The Practical Engineer

A monthly journal, devoted to the economical generation and utilization of power, and to the interests of stationary engineers

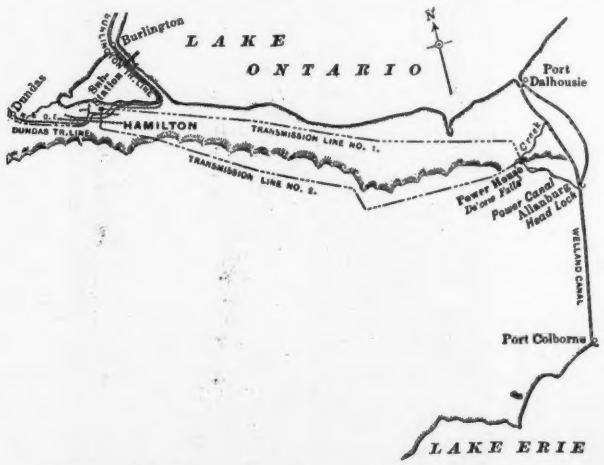
VOL X. PHILADELPHIA, DECEMBER, 1906. NO 11.

RETURN TO 207 MARKET
GENERAL
OFFICE,
ELECTRIC DEPT.
NEWARK, N. J.

Welland Canal Power Development at DeCew Falls

A 30,000 Kilowatt, 3-Phase, 22,500 Volt Canadian Power Transmission

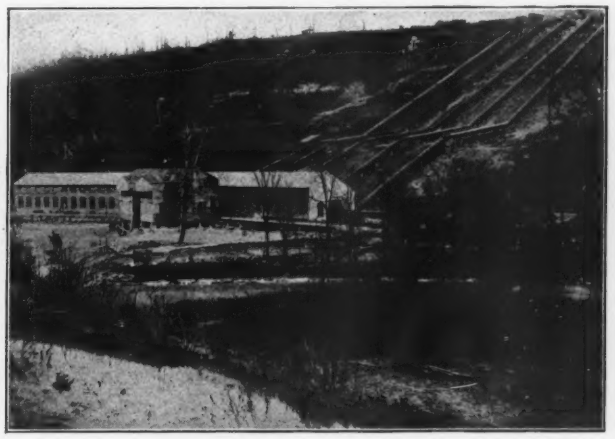
It is not generally known what a stupendous power development is projected, has been carried out, and is now under way between Lake Erie and Lake Ontario. There is no question but that within the next decade more than one-half of the



DeCew Falls Power Transmission Lines to Hamilton, Ontario, Canada

world's hydro-electric power will be developed in this section of Ontario, Canada, and Western New York. While the larger proportion of this power will be supplied by the six great power houses now under construction at Niagara Falls, there is already in operation a power plant at DeCew Falls, taking water from Lake Erie through the Welland Canal, utilizing a large proportion of the 50,000 horse power which may be developed from the water drawn from this canal, and there is every reason to believe that other large power developments will be made in that section of Ontario, Canada, between Fort Colborne and Hamilton. The great power canal taking water from Lake Erie and Niagara River through Lockport to Lake Ontario in New York State will also supply more than 100,000 horse power, and is said to be under consideration by the New York Central Railroad interests. The electric power from this canal would also be of value for the operation of canal boats and barges on the Erie Canal, about to be enlarged and reconstructed. These proposed plants, together with those at Niagara Falls, will ultimately develop, it is claimed, more than 1,000,000 horse power. The capacity of all the plants taking water from Lake Erie and discharging into Lake Ontario will equal at least one-half of the total power of the hydro-electric plants of the world. The power plants now in operation and under construction at Niagara Falls on the Canadian side, including that of the Canadian Niagara Poewr Co., with an ultimate capacity of 110,000 horse power, the Ontario Power Co. with 180,000 horse power, and the Toronto & Niagara Power Co. with an output of 125,000 horse power, give a total of over 400,000 horse power, while on the American side the power stations of the Niagara Falls Power Co. and the Niagara Falls Hydraulic Power and Mfg. Co., each with an output of over 100,000 horse power, make a total of over half a million horse power now under development.

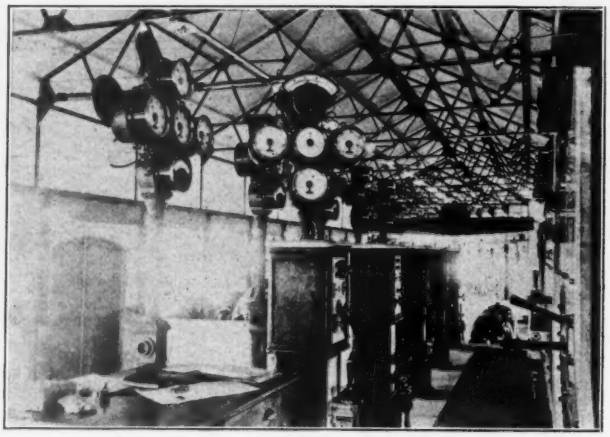
The hydro-electric plant at DeCew Falls is equipped with



Exterior of the DeCew Power House

four horizontal shaft turbine wheels of German construction. These are double-runner and double-discharge turbines operating at a speed of 286 revolutions per minute, with a capacity of 7,100 horse power. There are also two single-discharge single-runner turbines of the Italian type, having a capacity of

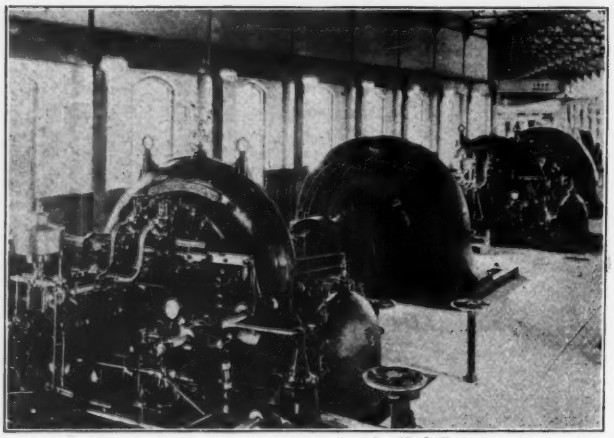
3,300 horse power each, at the same speed as the above-mentioned German turbines, 286 revolutions per minute. The Italian turbines are each directly coupled to a 2,000 kilowatt alternator of the General Electric Co. type constructed at the Canadian works. Two of the four 5,000 kilowatt alternators, driven by the German double discharge wheels of 7,100 horse



Switches and Measuring Instruments

power each, are polyphase machines of the Westinghouse type, having a capacity of 5,000 kilowatts each, and supplying a three-phase current having a frequency of 66 periods per second and a pressure of 2,400 volts.

In addition to the European turbines installed as above-mentioned, there are two single-discharge single-runner water wheels operating at a speed of 400 revolutions per minute, of the Stilwell-Bierce type, each developing 1,700 horse power, and directly-connected to 1,000 kilowatt Royal Electric alternators of the inductor type. The turbines for driving the excitors are also of the Stilwell-Bierce make, having a capacity of 50 horse power each, and driving 30 kilowatt Crocker-Wheeler direct-current dynamos at a speed of 800 revolutions

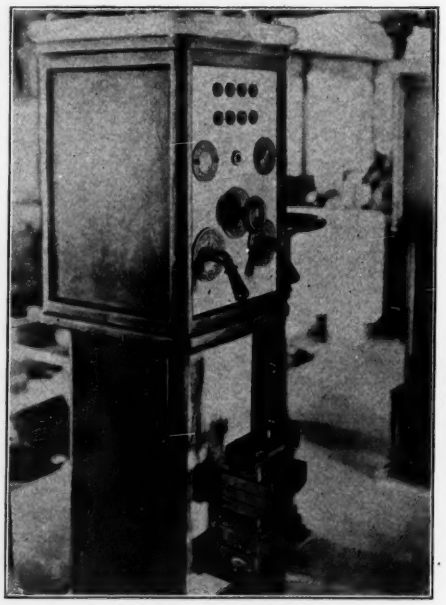


Interior of DeCew Falls Power Station

per minute. The 10 turbines above-mentioned operate under a fall of 268 feet, and are supplied with water from four steel pipes each 6.5 feet in diameter, connecting the power station below with the forebay on the brow of the escapement 250 feet above.

The current generated at this power station is transmitted to Hamilton, a distance of 35 miles, from the hydro-electric plant, at a pressure of 22,500 volts, the same as is used for transmitting power from Niagara Falls to Buffalo. The station also supplies current for a short transmission line 3 miles in length, at a pressure of 2,400 volts directly from the generators for the electric service of the city of Saint-Catherine. The step-up transformer house at the DeCew Falls power plant is equipped with 25 transformers of the oil-insulated water-cooled type, 20 of which are constructed by the Royal Electric Co., and 5 by the Westinghouse Electric and Mfg. Co. The latter transformers each have a capacity of 2,500 kilowatts or a total of 12,500 kilowatts, and are wound for a secondary pressure of 45,000 volts or 22,500 volts, according to connections made, the primary current being 2,400 volts, as supplied by the generators. The five additional transformers about to be installed will have a capacity of 3,300 kilowatts, and when these are installed together with the electrical generators, the power station will have a total capacity of nearly 30,000 kilowatts.

The current is conducted over two transmission lines from



Switch and Circuit Breaker Column

the power station to Hamilton, one of which consists of three stranded aluminum conductors each having a cross section of $^1/_3$ of a million circular mils. The other power transmission line consists of three solid copper wires and three stranded copper conductors arranged in pairs on three cross-arms each having two pins, the distance between each pair of conductors being 4.5 feet. The three-phase current may be transmitted to the Hamilton sub-stations, four in number, at either 45,000 volts or 22,500 volts pressure. One of the sub-stations contains 23 two-phase, three-phase transformers, the 2,400 volt two-phase current on the secondary being stepped down and changed from the three-phase 45,000 volt or 22,500 volt primary current. The smaller of these transformers have a capacity of 175 kilowatts each or a combined output of 1,400 kilowatts for the eight transformers of the Royal Electric type. The remaining 15 transformers are of the 500 kilowatt West-

inghouse type, making the total output of this sub-station nearly 9,000 kilowatts.

In addition to these static transformers there are in this sub-station three Westinghouse rotary converters of 300 kilowatts each, supplying a direct-current of 600 volts for electric railway service; these two-phase rotary converters having a speed of 667 revolutions per minute, and operating from the step-down transformers above referred to. A storage battery installation has also been provided of 4,000 ampere hours capacity, consisting of 255 cells, used largely for regulation. A motor generator has also been installed for power service in the city at a pressure of 500 volts, direct current being provided by a 200 kilowatt General Electric dynamo of Canadian construction directly coupled to a 300 horse power synchronous motor of the Royal Electric two-phase type. A number of General Electric constant-current transformers have also been installed for arc lighting, nearly 500 enclosed series arc lamps, using 7 amperes each, being utilized, the constant-current transformers supplying a current of 8,000 volts pressure from the secondary, the primary windings being connected with the two-phase step-down transformers supplying 2,400 volts with a frequency of 66 periods per second.

In this same sub-station there are two steam engines of the cross-compound non-condensing type constructed by Goldie and McCulloch, operating by direct connection two 1,000 kilowatt alternators of the Westinghouse type having the same frequency and voltage as those at the DeCew power station. The engines have a stroke of 42 inches and high-pressure and low-pressure cylinders measuring 28 and 54 inches in diameter respectively. The steam is supplied by four water tube boilers of the 500 horse power Sterling type, supplying steam to the above engines at a pressure of 170 pounds per square inch. The other sub-station has 24 step-down transformers having a total capacity of 12,000 kilowatts, one-half of which have already been installed, each having a capacity of 500 kilowatts. These are of the Westinghouse oil insulated self-cooling type, similar to those in the sub-station above described.

OIL IN BOILERS

Method of Treatment when this Undesirable Substance is Present

By E. H. Naylor.

Any engineer who has to contend with boilers that have a deposit of oil on the shell, head and tubes, especially the shell, has something that requires his immediate attention, and if not taken in hand as soon as the first traces of it are discovered, the chances for trouble, and serious trouble, are good.

The presence of oil in boilers causes considerable worry for anyone in charge of boilers when they first meet this kind of trouble, and as a rule most of the engineers or attendants in charge of oily boilers are bothered to know just how to proceed when it is their first experience; while those who have had this kind of experience will often find that it is not always convenient for them to proceed as they desire in getting rid of the oil that has accumulated, and they can only do their best to prevent any further oil accumulating until some time in the future they can lay the boilers up, one at a time, and then give them proper treatment.

The treatment of boilers for what may come along in the future wholly depends upon the conditions that exist in the plant. If the trouble comes from some recent changes or repairs, why it is somewhat easy to overcome the trouble. This kind of trouble may come from the oil due to cutting pipe threads or from material used in pipe joints, and is not important; but if the oil flows with the feed-water continually in a greater or less degree, due to the returns from the exhaust steam used for heating, this is bound to coat the inner surface of the boiler, and then it is a case of constant watch and no end of labor or worry to the attendant who may be so unfortunate as to have to contend with this condition, and it requires good judgment to meet all future trouble. No matter what precautions may be taken in installing the necessary apparatus for eliminating the oil when it is mingled with the feed-water, a constant watch is required at all times while these conditions exist.

Eliminators may be placed on the exhaust pipe of the engine, and if the proper and efficient one is selected it will do a lot of good, but care should be taken that the right one is selected because a poor one, instead of helping the cause, will be only one more piece of steam apparatus to look after with no results derived from it. Eliminators do not wholly fill the bill, even if the very best is selected, although they will help wonderfully, and to keep the boilers entirely free from oil, more or less soda must be fed in at intervals as the conditions require it. Often common sal-soda will be quite sufficient to keep the boilers in condition, but if there is a large percentage of animal grease compounded with the cylinder oil, it will require a more severe treatment. In the latter case caustic soda should be used, for it acts quickly and it will not require so much of it as soon as the attendant has control of the situation.

There is one objection to using any of the sodas, and that is it will stew out around the valve stems and will work through the packing on the gauge glasses and run down the glass, causing it to become of little use in a short time. If it is fed in very large quantities or in frequent small amounts, it also often works out around rivet heads and the rivets have to be caulked up or they would look bad, especially if they are on the front row of overhanging fronts.

When oil gets into a boiler it frequently works in between the plates at the girth seam and around the rivets, so that the soda is sure to follow if fed strong enough, and these rivets and seams should be caulked if they leak any soda through. The writer has had considerable experience with boilers having an oily deposit, and he has spent many hours of his time fighting it. During my first experience of this kind, I did not have the least idea how to treat it properly. I knew enough to use soda to try to kill what was in the boiler and also to help kill what was going in, but almost anyone would have known this much. I was at a loss to know how to treat it properly. I realized the treacherous nature of oil in boilers and it caused me many

extra hours of work over what it would have done had I known just how to proceed with my trouble.

Should any engineer be experiencing this kind of trouble for the first time, I would advise, at the very first opportunity after it has been discovered, boiling out the boiler with a strong solution of caustic soda, using 50 or 60 pounds of the soda and boiling for about 12 to 15 hours with a slow fire and the top manhole plate off. This is the quickest and best method to use, and once done and the proper precautions taken the trouble and worry in the future will be greatly reduced; but if this method is not followed up and the doping system is adopted, it will be a long fight and may eventually end with an overheated shell and consequently a bag of greater or less degree may be the result.

After a boiler is boiled out it should be allowed to cool down, and then let the water out, after which wash out thoroughly; examine the shell inside and see if it is free of all traces of oil and examine the outside for leaks. Should there be any leaks, they should be caulked before starting the boiler again.

After the boiler has started up, I have found a few pounds of caustic soda dissolved in hot water and thrown in with about a half gallon of kerosene, to be quite beneficial; then using just sufficient soda to kill what oil may pass in with the feed water and cleaning the boiler regularly about once a month will give the desired results. Once a boiler has formed a slight bag in the shell, there is no end of constant care and watching, and at each cleaning day it must be thoroughly cleaned off or the bag will soon be of increased size and may be serious enough to require cutting out and a patch put on.

Once I knew an engineer to get caught by not being as careful as he should have been, and who, after boiling his boilers out and getting them in good shape, took it for granted that he was safe and could handle them without any further trouble. The boilers were only running about a month when he found that they had bagged so badly that they had to cut out a considerable part of the first sheets and patch them. Had he followed the clean boilers up and had he kept on feeding soda, he would have saved considerable expense and delay.

There is another thing that is a good prevention, and that is to keep the heating pipes clean. Oil clings to the inside of the pipes and often comes down in clots, and when this happens is the time the oil gets a start on one. I have found by frequently slushing these with kerosene and allowing the returns to go to the sewer for a day or two while giving them this treatment, much trouble is avoided. The kerosene thus cuts the oil loose in the pipes, and it runs into the sewer instead of into the boiler.

Another good plan is to feed the soda-ash to the boilers at night after the plant is shut down, and allowed to remain still during the night, but it does a lot more good to pump it in on Saturday night, as it has a chance to remain about 36 hours, which is quite beneficial; then on Monday morning, in passing out with the steam, it helps to kill the oil in the feed-water returns, but it is hard on lubrication and it has often been a question in my mind whether this should be done. Of course, more oil must be fed to engine during this time, which increases our trouble somewhat, but in this oil problem some sacrifices must be made to accomplish the result we are after.

From experience I can safely say too much care and attention cannot be given to boilers when the feed-water is partly made up from the exhaust steam returns. It is a very easy matter to get into a scrape, but a long, hard fight to get out of it.

It might be said, why not use a good mineral oil for cylinder lubrication with a good oil separator, and then the trouble will be over? I will say I have tried all these schemes with very little success, for it is quite a job to get an oil that will not give trouble in boilers if not followed up and strict attention paid to it.

When I first took charge of the plant at which I am employed, 15 years ago, the oil on the one boiler was so thick it could be scraped off like mud, and it caused leaks in the girth seam over the fire and around the rivets; but this boiler never bagged any, whereas a very thin film of oil on one of the boilers we put in subsequently started the shell very slightly. The old boiler was scraped as clean as possible and boiled out with 75 pounds of caustic soda, and we escaped any trouble from overheating of the shell.

There is only one safe way to proceed if your boiler contains oil, and that is to get rid of it and do it as quickly as possible if you wish to avoid trouble.

Disadvantages of the Vertical Steam Turbine.

Of the two types of steam turbine in use, the vertical type at first sight seems the more attractive, but its advantages as regard space and regulation are offset by the use of a step bearing which requires a supply of lubricant under pressure, an arrangement that has usually caused considerable trouble. Moreover, the electric generator has to be located in the worst possible position, above the turbine, where it is exposed to the heat arising from the latter, together with what steam may leak past the shaft glands. Then, too, it is difficult to protect the generator from oil thrown from the upper bearings. Added to this is the inaccessibility of the vertical type for the occasional overhauling which is needed by even the best machinery. In the horizontal type the whole of the apparatus, turbine and generator, can be taken apart and re-assembled in a comparatively short time, and the turbine and generator can be worked upon simultaneously. In the vertical type, on the contrary, the machine has to be taken apart piecemeal, beginning at the top, and after the generator has been removed, the various discs of the rotating element of the turbine have to be stripped from the shaft one by one.

Boiler Explosion Kills Six.

Six men were killed and five seriously injured on November 12th when a boiler in the power house of the Lake Shore Railroad, in Collinwood, a suburb of Cleveland, O., blew up. The men were building a foundation for a dynamo close to the boiler when the explosion occurred. They were all in line with the end of the boiler which blew out, and were scalded by the immense volume of water which shot out. It is said that the explosion was caused by the formation of a "mud ring" in the filtering apparatus, which clarified the feed water, thus preventing the proper amount from entering the boiler. The shock of the explosion was heard for several miles.

80-Ton Fly-Wheel Bursts.

A 30-foot fly-wheel, weighing 80 tons, burst on November 6th at the Whitaker Iron Works, Wheeling, West Virginia, scattering pieces in every direction. A large section of the roof of the mill was blown off, and heavy pieces were thrown as far as 500 feet against neighboring plants. The workmen had sufficient warning and all escaped injury.

SOME WORKING TOOLS OF AN ENGINEER

Hammering, Chipping, Filing, Scraping, Reaming and Tapping

There are many different opinions expressed as to what should be the education of an engineer and to the man who occupies a good position, either as a running engineer, or a designing engineer, or to the engineer who has made his mark in this world, the solution of this question seems more or less easy. One man will say that his success is due to his wide

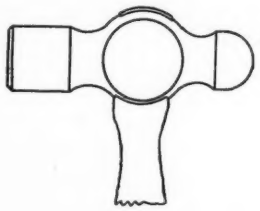


Fig. 1.

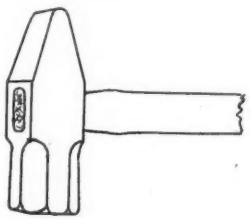


Fig. 2.

experience in many different positions, another will say that his success is due to his close study of things mechanical, obtained either from books or by observation; still another man will say that if it were not for his special training in the machine shop or in some engine works, he never would have occupied the position he holds today.

It is to the young man, one who is barely out of his teens, that this question bears the mark of perplexity. How and what shall he do to know most in the engineering profession so that he can leave his position of oiler, which he now occupies, and

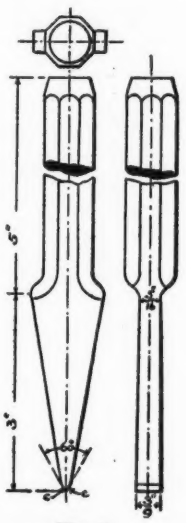


Fig. 3.

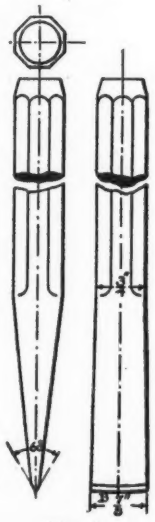


Fig. 4.

at some future time occupy the glass-enclosed office which his chief now occupies, or one similar to it? Regardless of which may be the best route to success, there is one passport that will certainly help him on to better things, and that is the proper handling of tools and the ability to make necessary repairs about any part of a machine. It is often the manner in which a man handles himself when filing a key-way or scraping a bearing that entitles him to be called a "born engineer."

Among the things which are necessary to be done by hand about the average plant, are hammering, chipping, filing, scraping, polishing, reaming and tapping. Hammering is done around the power plant for a number of purposes: for riveting, for peening, for driving chisels or on finished work, in which case a soft hammer is used. The two styles of hammers in general use are the ball-peen hammer or the cross-peen hammer, shown in Figs. 1 and 2. The ball-peen hammer is used for riveting, as in riveting a crank pin into a crank, in which case the crank pin is forced home under pressure, and to keep it from jarring out the end is riveted over. This should be done, not by hammering the edge of the pin over into the groove, but by hammering all over the end of the pin so as to spread the metal as little at any one point as possible. It should be begun by hammering around the outside and then in a circle just inside of that, and so on until the centre is reached, and

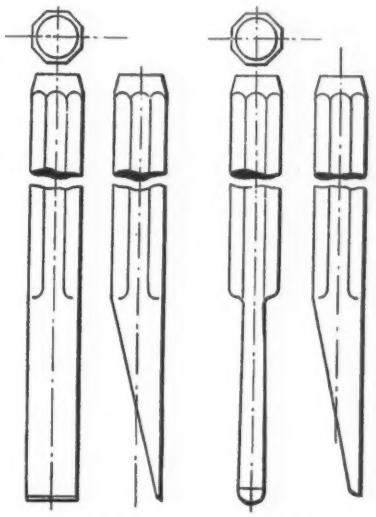


Fig. 5.

Fig. 6.

then beginning over again in the same way. The heavier the blow the deeper it will affect the metal, but a heavy blow should not be used near the edge, as it will likely crack the material.

Peening consists of stretching the surface of the metal, and the exact method for doing this must be learned from experience. If a surface is struck by a ball-peen hammer, it will spread the metal equally all around, provided the blow is straight. If it is struck by a cross-peen hammer, the metal will stretch in the direction of the handle of the hammer. If any warped surface is to be straightened by peening, it should be peened in a series of rows from one low corner to the other, thus stretching the concave side and bringing the two high corners down. Soft hammers are usually made out of low grade Babbitt or lead, and are used when the work which is to be struck must not be injured in any way.

The hammer generally used for chipping is the ball-peen hammer, which varies in weight from 1¼ to 2 pounds, one weighing about 1½ pounds being mostly used. The handle

should be of split hickory, well fitted into the eye of the hammer. The eye should be enlarged at one end so that when the handle is fitted into it, the outer end may be split and a wedge of metal or wood driven into it, in order to secure the hammer firmly to the handle.

When chipping flat surfaces the chisels used are the cape

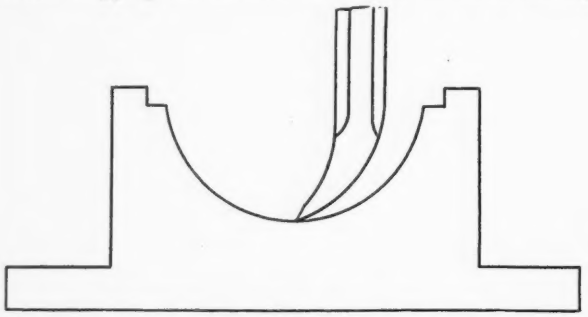


Fig. 7.

chisel, shown in Fig. 3, and the flat chisel, shown in Fig. 4. When chipping a broad surface it is best to run a series of parallel cuts across with the cape chisel, and then take out the material between with a flat chisel. The width as well as the depth of these cuts will depend a great deal upon the material which is being worked. The average cape chisel is about ¼ inch to ⅜ inch wide, and a flat chisel about ⅞ to 1 inch wide. The cape chisel should have a clearance back of the cutting edge to prevent the chisel from becoming wedged in the groove and to allow a slight slide motion in order to guide the chisel. The usual length of cold chisels is 8 inches. They are generally made from ⅝ to ¾ inch octagonal steel, and are forged about 3 inches back from the cutting edge.

The angle of the cutting edge of a cold chisel is made about 60 degrees, but for the softer materials the angle may be reduced to 30 degrees. The angle at which the chisel should be held is soon found by the user, since if it is held too low the cut will run to nothing, and if it is held too high the cut will grow deeper. If too great a depth of cut is attempted, the metal is apt to break out ahead of the chisel deeper than the bottom of the required cut. This is particularly true of cast-iron. The cutting edge of the flat chisel should be slightly rounded, shown at B, Fig. 4, so as to prevent the corners from cutting in, while the cutting edge of a cape chisel should be flat, shown at CC, Fig. 3.

Other forms of chisels are used for special purposes. Fig. 5 represents a side chisel which is used for chipping the sides of slots and special work of that kind. Fig. 6 represents a grooving chisel which is used for cutting fillets and for chipping oil grooves in flat surfaces. This chisel can be made by grinding a cape chisel with a round point or by grinding off the edge of a prick punch. A curved chisel must be used when cutting circumferential grooves, and is shown in Fig. 7. A gouge or half-round chisel, shown in Fig. 8, is used for fillets. It is also used for rough work in place of cape or flat chisels. When using the gouge chisel for flat work, a series of parallel cuts is taken across the work and then another series which cut out the ridges between the first cuts, and so on until the required depth is reached, when the work is finished with a flat chisel. The diamond point chisel, shown in Fig. 9, is used for many purposes, among which may be mentioned the squaring out of corners and the like.

Chisels for use on cast-iron should be tempered to a blue color, which is found to be about the proper hardness to maintain a good cutting edge. The common method is to heat the piece slowly until a distinct color appears, caused by a thin scale of oxide, which is formed by the contact with the heated steel and the air. A faint straw color is visible at about 450 degrees, and blue is reached when 600 degrees is obtained, at which color it should be dipped. After the proper temper is attained, the edge should be ground to the proper angle on a wet grindstone or emery wheel.

Filing is one of the important things which is not generally properly understood, and to be able to file a surface perfectly flat is a harder task than is generally supposed. There are various kinds of files, which are classified according to the character of the teeth and with reference to the coarseness of the teeth. With reference to the character of the teeth, they are divided into single-cut, double-cut and rasp-cut; and with reference to coarseness of the teeth, they are divided into rough, coarse, bastard, second-cut, smooth and dead smooth. The coarse and bastard cuts are used upon the coarser and heavier classes of work, while the second-cut and smooth are used for the finer grades and for finishing the work started by the coarser files. A single-cut file is one in which a single, unbroken course of chisel cuts is made across its surface, arranged parallel to each other but oblique to the axis of the file. The double-cut file has two courses of cuts crossing each other, while the rasp-cut consists of a number of single points. The rasp file then cuts away the metal in a series of grooves, the double-cut in nearly the same manner, the cutting corners being the angle where the two cuts meet, and the single-cut file makes

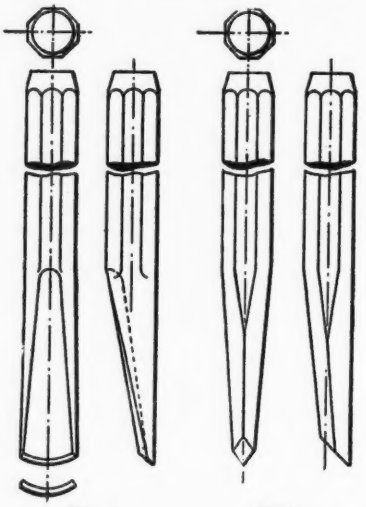


Fig. 8. Fig. 9.

a shearing cut and leaves the surface smoother for the same coarseness of cut.

Files are also designated by the shape, as, for instance, flat, half-round, circular, quadrangular and triangular sections, and also by their outline, as taper and blunt. A blunt file preserves its sectional shape from point to tang, while a taper file gradually narrows from about two-thirds the length to the point.

When filing flat surfaces, it is necessary that the file be slightly convex, since it is impossible to push a file perfectly straight, so that if the file cuts on comparatively few teeth at one time, the surface can be filed smooth by increasing and

diminishing the pressure necessary for the proper cut.

When finishing some surfaces, such as a connecting rod, it is customary to draw file it. This is done by grasping the file in both hands and drawing it at right angles to its length, pushing and pulling the file until a very smooth surface is obtained.

Scraping is perhaps one of the most important things connected with hand work that an engineer is called upon to do. It requires patience and skill, and unless properly done a good fit cannot be expected between the two surfaces that must fit together.

Scrapers are tools resembling files in shape. They are some-

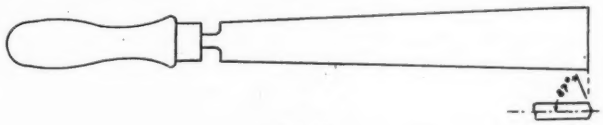


Fig. 10.

times made from old files when nothing better is available, but specially made scrapers should be used when possible. They are generally ground square at the ends and are then oilstoned to shape them, as shown in Fig. 10. An Arkansas oil stone should be used, since it is very hard, as the scrapers are left glass hard without drawing the temper, and the edge must be put on the scraper by pushing it along at nearly 90 degrees to the stone.

Scrapers are made in various sizes, ranging from ½ inch wide by 6 inches long, to 2 inches wide by 2 feet long, the average size being 1⅛ inches wide by 12 inches long. The thickness varies from ⅛ to ¼ inch, drawn in a long taper to about $^1/_{16}$ inch at the point. The cutting end should be slightly rounded to avoid the corners scratching. The length of stroke will vary from 3 inches to 4 inches, when roughing out, to a very small stroke, when the finishing touches are put on. The amount of metal to be scraped off is regulated by the pressure of one hand near the cutting end.

The general run of flat work is scraped to fit surface plates, or if two surfaces rub together it can be assumed that one is perfectly flat and the other surface scraped to fit it. In scraping it is customary to coat the surfaces with red lead, which not only acts in some measure as a lubricant, but gives indications, after the surfaces are rubbed together, of the high places which should be scraped off. The points of contact are shown

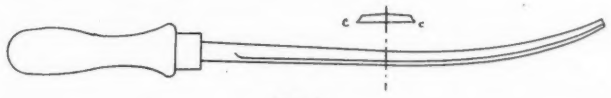


Fig. 11.

by a darkening of the surface, and these high spots should be scraped off and also some little distance around the high spot. The surfaces should be again covered with fresh red lead and another bearing taking, and the high spots again scraped off. This should be continued until the bearing spots come close to each other, which, for general purposes, should be about an eighth to a quarter of an inch apart.

When fitting up soft metal or bronze bearings for engine shafts, etc., it is necessary that a good bearing be had. For such work a scraper of the form shown in Fig. 11 is used. Its cutting edges shown at CC are ground at an angle of about 75 degrees for soft metal. The scraper is used by moving it both around and lengthwise of the box, at the same time with a peculiar twisting motion. It is grasped with one hand at each end and the cutting is done by either a pushing or a pulling cut. For cast-iron boxes, the sides of the scraper should be ground about square to give the proper working edges.

Another operation which often must be performed is reaming. After a hole has been drilled or bored, it is often necessary to finish it with a hand reamer. This is a solid piece of steel with cutting edges formed by flutes running lengthwise. Solid reamers are used when it is not desirable to ream holes of varying sizes, while adjustable reamers may be made to cut holes a trifle smaller or larger than their own size. Among the different kinds of reamers used for producing a straight hole may be mentioned fluted hand reamers, fluted chucking reamers, roughing reamers, rose reamers and single-lip reamers, each of which has its special uses. For reaming out taper holes, taper reamers are used.

Tapping and threading are two very frequent occurrences around the power plant. Taps larger than ¼ inch are made in sets of three, as shown in Fig 12, and are termed taper, plug and bottoming taps respectively. In cutting the thread the taper tap is used first, then the plug tap, and lastly the bottom-

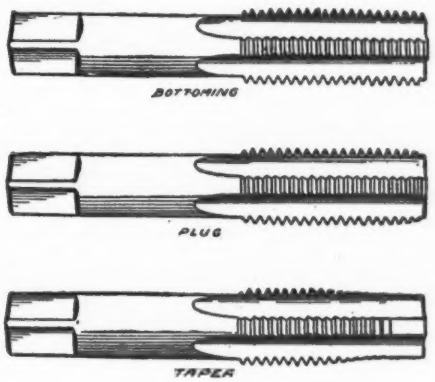


Fig. 12.

ing tap, which is the exact size of the thread and reams out the thread cut by the other two taps.

Thread-cutting dies are made both solid and adjustable. Solid dies are used for roughing out a thread that is to be finished by an adjustable die, and they are also used where accuracy is not essential. Solid dies are used on bolts and for cutting threads on pipes, as pipe threads, are made tapering, and the diameter may be varied by the distance the die is run up on the work. The size of a die is always denoted by the size of the screw to be cut, regardless of the stock from which it is to be made.

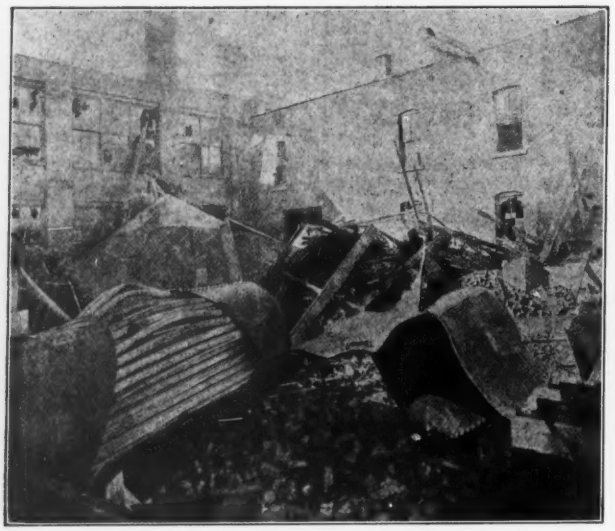
Most dies for particular work, as for machine threads, are made round and adjustable. They generally have four cutting edges and are provided clearance holes to allow chips to get away and the lubricant to get to the cutting edges. The die is chamfered on one side so that it will start easily on the stock to be cut, a fine pitch being chamfered for three threads, while a coarse pitch is chamfered four threads. When any kind of thread is cut with a die, it should be backed off frequently so that the chips will not strip the thread, and some lubricant should be used on the die, especially if iron or steel is being cut.

BOILER EXPLOSION IN LAUNDRY POWER HOUSE

Serious Explosion of 125 Horse Power Tubular Boiler at Buffalo, N. Y.

An explosion of a tubular boiler on Saturday afternoon, November 3d, wrecked the boiler room of the American Palace Steam Laundry, located at Buffalo, N. Y., instantly killing two men and seriously injuring two others. There were two boilers in the wrecked building, one of which exploded, causing the other to do likewise. The force of the explosions carried down the four walls of the building and tore the roof to shreds. One of the boilers was thrown into the street on which the building was located, while the other boiler was torn from its foundations and had a hole knocked in its top, from which several of the tubes projected.

It was exactly 4.20 P. M., on Saturday afternoon, when the explosion occurred. Work for the day was about over, and



Result of the Explosion at the American Palace Steam Laundry Buffalo, N. Y., on November 3rd.

of the 175 employees, mostly women and girls, all but 25, who worked in the mangle-room, had gone home. The delivery wagons, with the exception of two, had left the factory. When the explosion occurred these two wagons were caught in the explosion. The driver of one of the wagons was killed, the wagons were wrecked and the two horses were so badly hurt that they had to be shot. The driver of the other wagon owes his life to the fact that he had just gone into one of the buildings.

The boiler-house occupied the northwest corner of the laundry property, and was separated from the rear part of the main building by a chimney. The building was one and one-half stories high, but after the explosion nothing was left of it except the big brick chimney, which remained firm on its foundation. Two boilers were in use. They stood about 10 feet apart, their length running parallel to the street. The boiler which burst was the farthest from the street, and in its flight it knocked a hole in the other boiler.

The buildings surrounding the boiler-room, although separated from it by only a dozen feet, escaped with comparatively slight damage. The workrooms in the rear were most severely damaged. The mangle-rooms are on the first floor in the rear of the boiler-room, and the 25 girls at work climbed out of the windows, every pane of glass of which was shattered.

After the explosion it was found that E. O. Simpson, the night engineer, was missing. At first it was thought he had not arrived, but he was seen riding his bicycle into the driveway about two minutes before the explosion. About four hours after the explosion a thorough search revealed his body in the fire-pit of the boiler-room. Simpson had barely arrived inside the door and apparently was walking in front of the boiler which burst, when he was caught in the concussion and covered with falling *débris*. Simpson's trouser-guards had not been removed from his ankles. His silver watch was running and marked the hour at which he was discovered.

Of those seriously injured, Thomas McClune, fireman, was so badly injured that he did not recover. He was standing in front of the boiler which burst, and was severely scalded by steam and burned by the fire which was blown out of the boiler's firebox by the force of the explosion. He was blown out through the door and into the driveway, where he was dug out by employees who went to his rescue. A. P. Smith, the watchman, was also seriously injured by scalding and concussion of the brain. He was talking to McCune at the door of the boiler-room and the full force of the explosion did not strike him.

The boilers were of 125 horse power each and were made by a local firm. It was stated by William Mason, the chief engineer, that the boiler which burst was four years old; that it was examined and tested internally last January and externally about two months ago by the inspector of the Company which insured the boilers. The boilers ordinarily carried 95 to 100 pounds of steam, and the chief who passed through the boiler-room a few minutes before the explosion, said that the fires were being banked as the engines had been shut down a half-hour before and a less pressure of steam was being carried. The machinery in the mangle-room was being run by a gas engine.

After the explosion the ruins took fire, but it was soon extinguished by the fire department.

A Pugilistic Engine Governor.

When inventors have exhausted their mechanical genius in attempts to secure patents, they often turn to other methods to secure the coveted approval of the Patent Office. One of Office is a governor for steam engines which is cast in the the most amusing in the engineering field found in the Patent shape of a pugilist with the unmistakable features of John L. Sullivan. The revolving iron spheres are cast in the shape of boxing gloves. As the mechanism revolves it gives a fairly good impression of a boxer. This governor has not come into general use, but it causes all visitors who see it to smile.

ARITHMETIC FOR ENGINEERS

By E. S. Hawkins.

Part I.

Probably every engineer at some time or other feels the need of the ability to figure rapidly and accurately. This knack of figuring may be acquired easily if certain fundamental principles are kept in mind. These principles most of us learned long ago in our boyhood days, that now seem to be as far in the past as the things then learned are vague in the memory. Perhaps, then, a little review to brighten up the rusty spots may not be considered out of place. We strive not alone for the attainment of the ability to take pencil and paper and laboriously figure out some of the simpler problems, but also for that accomplishment that enables a man, amid the turmoil of many duties, to turn a matter over in his head and estimate accurately what must be the result of certain conditions. This may be called the mathematical turn of mind and is one of the distinguishing traits of the thorough-going engineer.

What the engineer wants is the mind's eye that views things in their correct proportions rather than with the more transcendent imagination of a poet. Some of our greatest feats of engineering have ben laid down on the blackbord of the mind before ever a figure was made. It is said that the subway engines were laid down to practically the exact dimensions in the head of their designer before anything was committed to paper. Indeed, one should never take up a pencil to figure out a problem until he has settled in his mind exactly how the figuring is to be done. Any other course than this leads to an indecisive frame of mind that is detrimental both to rapidity and accuracy in mathematical work. Qualities that result in thinking of this kind are to a certain extent born with a man, but are also, and perhaps to a greater extent, the result of mathematical training and exact habits of mind. Here, as in all other lines of work, the beginning must be with the simpler things and proceed to that which is more abstruse.

Starting, then, at the beginning, let it be said that arithmetic, which is the foundation of all mathematics, is "the science of numbers and the art of computation" or the "knowledge of numbers and their use in computation." In its simpler forms, arithmetic is found in the computations of the workshop, and from here the use of figures branches out to all of the various lines of engineering until finally it goes beyond the bounds of simple arithmetic into the wider fields of the higher mathematics as applied in the designing office and the more complex problems of practical engineering. From the mere summing up of the items in an expense account to the laying out of the design for a Corliss engine, may seem to be a long stride, but everything becomes simple when the subject is approached with the determination to master each of a series of short steps.

The beginning of the system is the single thing or unit, and a number expresses a unit or combination of units. When a number refers to a particular thing or things, it is concrete; as, five engines, four valves. When, on the other hand, a number does not designate a particular thing, it is abstract; as, sixteen, seven. Like numbers designate the same class of objects; as, seven screws, three screws. Unlike numbers point out things in different classes; as, eight pulleys, nine girders. These definitions may sound like the preliminary abstractions of the theorist, but they are not. Once a person has so become master of himself that he marks all his results in the different steps of computing a problem, a great gain has been made in the direction of accuracy. A result may be numerically correct, but unless we are acquainted with the calculation performed, we have no means of knowing what the number given as the answer represents. A considerable percentage of errors can be properly attributed to the neglect of these simple definitions and the combining of unlike or unrelated units; thus, in figuring the horse power from an indicator diagram, men have been known to take the length of the stroke in inches instead of feet, so that they later catch themselves in the absurdity of trying to combine inches with pounds to get foot pounds. The absurdity of the error, which would never have occurred if the man had properly mastered the definitions of the different kinds of numbers, does not usually tend to decrease the chagrin of the erring person.

In arithmetic there are the five distinct processes of Notation and Numeration, Addition, Subtraction, Multiplication and Division. Notation is the expression of numbers and may be done by words, letters or figures. Numeration is the art of reading numbers. Subtraction is the reverse of addition, as is also multiplication of division.

Two systems of Notation, known as the Roman and the Arabic, are commonly employed, but the Roman, since it is used only occasionally, needs but little notice. This system was so named from the fact that it is supposed to have been first used by the Romans. The system employs seven capital letters to express numbers; thus, *Letters* I, V, X, L, C, D, M, with *values* of one, five, ten, fifty, one hundred, five hundred, one thousand. When a letter of any value precedes one of greater value, it is to be subtracted from this latter; thus, IV = 4. If a letter of any value follows one of greater value, it is to be added to that letter; thus, XI = 11. If a letter of any value comes between two letters of greater value, it is to be taken from the sum of these two letters; thus, XIV = 14.

Most important of the two systems is the Arabic, which is in common use by all civilized countries. It was first introduced into Europe by the Moors or Arabs, who conquered and held possession of Spain during the eleventh century, but did not receive attention until taken up by scientific men in Italy and from them generally adopted throughout Europe about the beginning of the thirteenth century. Formerly the system was supposed to be an invention of the Arabs, but it is now known that this people adopted it from the Hindoos by whom it has been in use for more than 2,000 years. The ten characters of the system from 0 to 9 inclusive, are too familiar to need further explanation. Zero has no value and is used simply to alter the value of other figures. The value of any unit may be local or individual, depending on the order in which it is placed in a horizontal row of figures. The right-hand unit is of the first order, while the next unit to the left is of the second order, the second to the left the third order, and so on. Ten units of any order make one unit of the next higher order. In any

number the orders are subdivided into groups or periods of three each, which are separated by commas.

Taking, for example, the number 432,973,568,753,861, the first figure to the right is 1 and is in the units place, while the next to the left represents 6 tens, and the next in order 8 hundreds. First to the left of the commas is the figure 3, representing 3 thousands. In this way we proceed through the tens and hundreds of thousands and the units, tens and hundreds of millions, until finally we have the whole number, which reads: "four hundred and thirty-two trillion, nine hundred and seventy-three billion, five hundred and sixty-eight million, seven hundred and fifty-three thousand, eight hundred and sixty-one." It will be seen that this number has five periods and the successive periods after this are named as follows: 6th, Quadrillions; 7th, Quintillions; 8th, Sextillions; 9th, Septillions; 10th, Octillions; 11th, Nonillions; 12th, Decillions; 13th, Undecillions; 14th, Duodecillions; 15th, Tredecillions; 16th, Quatuordecillions; 17th, Quindecillions; 18th, Sexdecillions; 19th, Septendecillions; 20th, Octodecillions; 21st, Novendecillions; 22nd, Vigintillions.

Addition is the process of uniting two or more numbers into one number equivalent to the two combined. The result is called the Sum or Amount. Only like numbers can be added; thus, four tons and five tons, make nine tons, whereas four tons and five miles cannot be added. The perpendicular cross, called plus (meaning more), and written +, is the sign of addition. Two horizontal parallel lines, =, mean equal. Example of use: A man has eight dollars in each of his hands. Eight added to eight equals sixteen, or, $8 + 8 = 16$.

In adding numbers of several orders, as tens, hundreds, units, the figures must be placed so that units come under units, tens under tens and so on. Each column can then be taken up successively, beginning at the lowest number, which is the first figure on the right and always is in units place. Take this example: Add, $3,126 + 235 + 21 + 954$. The figures 6, 5, 1 and 4 are in units position, and must be one above the other in the first column. The same is true of 2, 3, 2 and 5 in tens place.

Begining at units, add each column separately. The first column when united makes 16, *i.e.*, 6 units or ones and 1 ten. Place the six below the line under the first column, and add the one to the next column with the tens; thus, $2 + 3 + 2 + 5 + 1 = 13$, of which put the 3 in the tens row and carry the 1 to the next place, where we have 13 again. Repeat the process of putting down the three and carrying the 1 over to the thousands place, where it is added to the 3, and, since this is the last number, is put down and the whole sum or amount reads 4,336.

These are, in brief, the rules for adding: Write the figures so that all the figures of the same order are in the same column. Units under units, tens under tens, etc. Commencing at units or the right-hand column, add each column separately and, if it be one figure, write the sum at the foot of the column. If there is more than one figure, put down the right-hand one of the two or more, and add the rest to the next column at the left. Write down the whole sum of the last column.

Subtraction is the process of finding the difference between two numbers. It is the reverse of addition. The number from which another is taken is called the Minuend, and is always, and of necessity, the larger number. The number which is subtracted is called the Subtrahend. The number left after subtraction is the Remainder or Difference. A short dash, —, minus, is the sign of subtraction. It means less. Example, 6 less or minus 3, equals 3, and is written $6 - 3 = 3$.

In writing a problem in subtraction, be sure to put the larger number above for the Minuend. Then write the Subtrahend, putting units under units, tens under tens, as in addition. Beginning at the right-hand side, subtract the lower figures from the upper. Example: Subtract 113 from 425.

Here, beginning at the right, we took 3 from 5, which left 2. The next figure, 1, subtracted from 2, left 1, and the third 1 from 4 leaves 3. This completes the process, and the answer is 312, which may be proven by adding the Difference, 312 to 113, the result of which is the Minuend 425. Another proof is subtracting the Difference from the Minuend to give the Subtrahend, 113.

When a figure in the Subtrahend is larger than the one above it in the Minuend, the process is a little more complicated. It is only necessary to remember, however, that we can always borrow a unit from the figure next to the left in the Minuend, and as this unit is always one order higher, it adds to 10 instead of 1. Take, for example, this problem: From a tank containing 823 gallons of water, 679 gallons were drawn off. How many were left? Taking the larger number for the Minuend and placing the other under it, we have $823 - 679 = 144$.

In this we see that 9 is greater than 3, so we take 1 from 2 and leave it 1. This adds 10 to 3 because 2 is in the place preceding 3. Thus, 3 becomes 13, and now it is possible to subtract 9, which gives 4 as part of the answer. In the next the process is repeated. Remember that as we took 1 from 2 we have only 1 left, so that we must borrow from 8 in order to subtract 7. Thus, 2 becomes 11, and, subtracting the 7, 4 is left. The last figure, 8, has been decreased by one, leaving it 7. Take 6 from 7 and place the Difference, 1, under the column where it belongs, when the problem is finished.

All of this is done in less time than it can be written, and the borrowing and carrying processes are done mechanically, as it were, without repeating the different units to oneself or focusing the attention on anything other than seeing which of the two figures is the larger, and writing the result.

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Explosion of a Threshing Machine Boiler.

A serious explosion of a threshing machine boiler occurred on November 2d, near Livingston, N. Y., in which one man lost his life and several others were more or less seriously injured. The boiler had been filled with water a few minutes prior to the accident, and was standing still generating steam. The attendant who ran the engine had just stepped upon the platform and had his hand on the lever ready to start, when the boiler exploded. The force of the explosion hurled the heavy drive wheel high above the telephone poles and overturned the engine, killing a workman standing near. The attendant and several others working near the engine were injured by the flying pieces. It is said that the boiler was recently repaired, but had not worked satisfactorily since that time.

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The mountain streams of Colorado are going to be harnessed for commercial uses, and it is announced that Thomas F. Walsh and Myron Herrick, ex-Governor of Ohio, will spend $7,000,000 on the project.

POUNDING AND THUMPING IN STEAM RADIATORS

By W. H. Wakeman.

Unnecessary and annoying noises in steam radiators and heating coils are so frequently heard even in plants that were erected by experts, that a few suggestions concerning plans that have been adopted for the purpose of overcoming objectionable features and proved successful, will be interesting and instructive.

In a certain large room a pipe radiator, or more properly speaking, a bank of pipes, were installed for supplying heat. It was on the corner of a building, hence the pipes were located on one side and one end, under the windows. They were given sufficient pitch from the inlet to the outlet to insure proper drainage, and for several months worked quietly; then trouble commenced, as pounding and thumping in the pipes rendered it very unpleasant for all concerned.

Investigation showed that the riser (or vertical supply pipe)

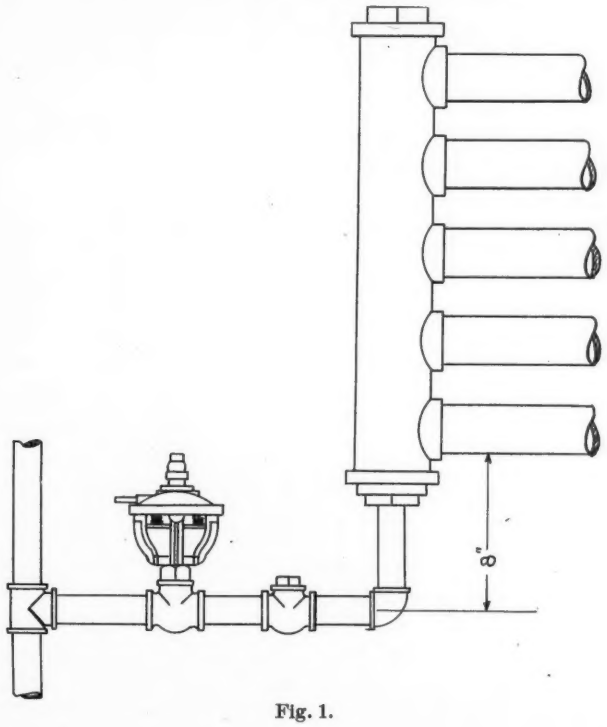

Fig. 1.

had settled, and of course it carried the inlet header with it; but the supports on the side of room all settled about the same amount, hence the pitch was not altered so far as this part was concerned.

The outlet end remained at its original height, hence from the corner to this point the pipes were practically level, and when steam was first turned on in the morning it took a long time for the water to drain out. Steam was shut off and turned on automatically through the day, hence when it was shut off water remained in the level pipes until it became cool; then when steam was again turned on it came into contact with this cool water, and pounding resulted as a matter of course.

The hook plate nearest the corner of room on the side was raised enough to give the second half of pipes sufficient pitch to clear them of water, but not enough to take all pitch out of the first half, which resulted in quiet operation of the system in this room.

It is a good idea to put a swing check valve in the outlet pipe

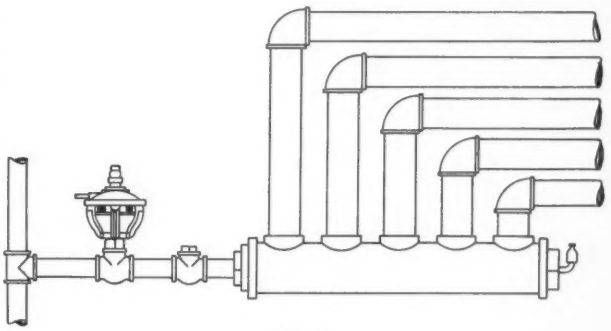

Fig. 2.

of a radiator or coil, in order to prevent steam from backing up and closing the air valves before all air has escaped. It is necessary, however, to arrange the piping so that a column of water at least 8 inches high can stand above the check valve without rising into the radiator or coil, as this will be enough to open the check valve provided it is in good order. If this is not done water standing in the pipes will cause much noise

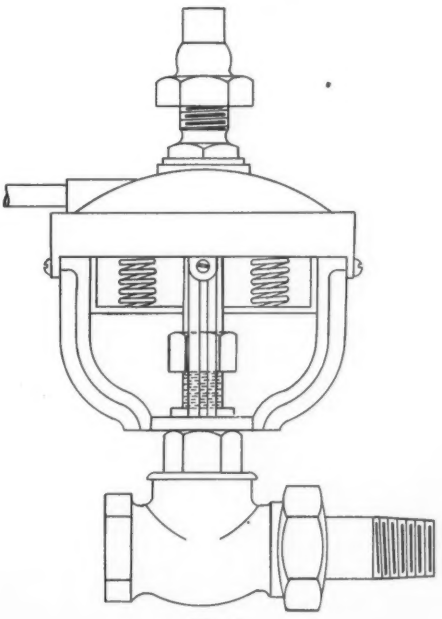

Fig. 3.

when steam is turned on, and furthermore it will prevent the free escape of air. This point is illustrated in Fig. 1.

So little regard is paid to this matter by some steam fitters that I have seen a check valve located on a level with a header on the outlet of a coil, as illustrated in Fig. 2. This coil

pounded so badly and was air bound so frequently that it could not be used. Sometimes water will drain out of such a coil if the disk of the check valve is removed, but that defeats the object for which the valve was installed and should be avoided if possible.

Another point thought out by these illustrations is the operation of automatic valves for shutting off steam by compressed air acting on comparatively large rubber diaphragms. Spiral springs are provided for opening the valve when air pressure is removed, and they work well so long as the valve stem moves easily; but if the packing around this stem has become hard instead of elastic, as it was when new, and it is compressed by the nut more than it ought to be, the valve remains closed (after steam has ben turned on at the other end of coil) until some of the pipes are filled with water which runs out of the air valve and floods the floor.

To remedy this evil, close the valve by hand while all air pressure is shut off from the diaphragm; then turn the nut backward slowly until the springs open the valve. It will then operate without further attention. A few drops of kerosene oil on such a valve stem will tend to keep it in good working order.

This will not only allow the radiator to heat the room as it was designed to, but prevents loud pounding caused by opening such a valve by hand when there is a body of cold water behind it.

An automatic valve is further illustrated in Fig. 3. Owing to brackets which must be used to support the upper part, it is very difficult to get a wrench on the stuffing-box nut so as to turn it, but by taking a pair of small gas tongs or pliers this nut may be grasped in any position, the same as if it was a piece of pipe, and turned as desired. As a rule I do not recommend the use of such tools on nickel-plated work, but in this case the teeth span the corners, and as but little tension is required, the nut is not disfigured. It is a good idea to have a special wrench made for this purpose.

In another case water churned back and forth frequently and sometimes it thumped badly. There was more than one radiator concerned in this, and the cause of trouble was not readily located, as the noise was not always in one place. These radiators were fed by a pipe under the floor of this room and near the ceiling of the room below it.

Careful observation located the cause of trouble, which is illustrated by the full lines in Fig. 4. The steam supply pipe pitched in the wrong direction, as it rises toward the radiator. The steam fitter evidently calculated that water resulting from condensation of steam in this pipe would slowly flow back to the riser, but it does this only when little steam is wanted. At other times the returning water is met by a current of steam which forces it toward the radiator until the vertical pipe is reached. It has then gathered sufficient weight to flow against a light steam pressure, hence the churning and thumping.

A little consideration of the matter will show the reader that in cold weather more steam is wanted for heating than when the temperature is higher, and this, of course, results in more water in the steam pipe, as it is not covered but was intended to form part of the radiating surface. An increase of the amount of steam and water to be delivered in both directions naturally results in greater conflict of forces and more of the disagreeable noise above mentioned. When we know that this pipe is about 56 feet long, we can easily understand that there is much chance for trouble, especially as the pitch for this distance was but a few inches. If it is practical to give such a pipe a pitch of about one inch to five feet in length, it will work better.

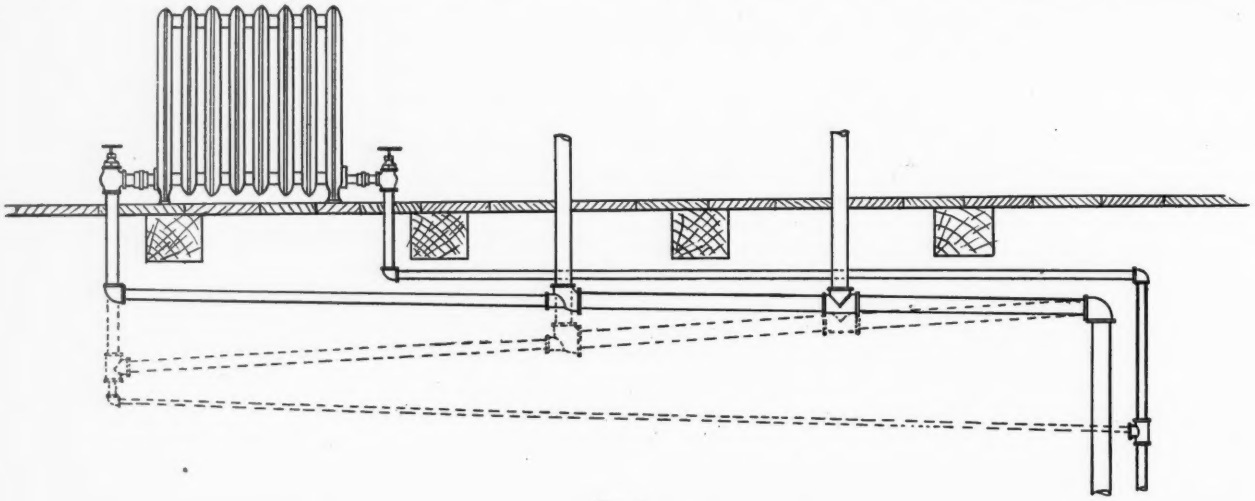

Fig. 4.

The dotted lines in Fig. 4 show the proper location of this pipe, although the pitch is exaggerated to make the idea more plain, for but little is needed where it is in the same direction that the steam flows. A drip pipe is connected at the end of this horizontal pipe (using a tee instead of an ell), and is carried back to the return riser as shown. This will keep the steam supply pipe clear of water, and deliver dry steam to the radiators above.

A common source of trouble in some buildings where steam must be admitted and shut off by hand, is that inexperienced persons will open the inlet valve only when they want to turn on steam, apparently neither knowing nor caring where the resulting water is going. If they find both valves open and the room too warm they shut the outlet, thinking that it is only necessary to close one of them.

That certainly will reduce the supply of heat, but at the same time will increase the stock of water on hand, and opening the inlet valve only gives the same result. Somebody who was in-

terested in air valves tried to show the writer that a certain kind would prevent water from running out on the floor because it was warranted to return all water that came to it back into the radiator.

It is possible for an improved air valve to do this where both inlet and outlet valves are open, but it is plainly impossible for any air valve to dispose of water that is supplied constantly as under the above-mentioned conditions. The only way to insure a safe disposal of water from this source is to connect small outlet pipes to the several air valves, and let them discharge into a sink or some other suitable place in the basement or elsewhere, through one or more larger pipes, each of which takes the water from several of them.

When a radiator is found in this condition, the outlet valve must be opened and sometimes it does no special harm if no further precautions are taken; but it is safer to close the inlet valve first and let the water work out slowly. Under former conditions, violent pounding and thumping will at once be heard when steam comes into contact with comparatively cool water, and the resulting water hammer may burst a cast-iron radiator; therefore it is well to remove all steam pressure, leaving the outlet valve open until the radiator is slowly heated.

Where the drip pipe from a radiator is long and owing to local conditions it can be given but slight pitch, the results are not always satisfactory, for if air collects at any point in it (and this is sure to happen in course of time) trouble is sure to follow.

A case of this kind proved very exasperating to the writer some time ago, during the progress of an interesting and instructive lecture. Near its close a large radiator near the lecture platform commenced to give forth unmistakable signs of distress that were heard in all parts of the hall. Of course, any attempt to remedy the evil at that time would have added to the confusion, therefore it could only be left to its fate.

The drip pipe in this case was about 50 feet long before it discharged into the main return pipe with a pitch of only a few inches, which could not be increased as it passed over doorways, spanned a wide hall, etc., therefore it had to be kept up high out of the way.

An ell near the main return pipe was taken out and replaced by a tee, into the outlet of which a nipple was screwed followed by a valve. This makes it possible to blow all air out of this long pipe in a few minutes. Special care should be taken in all such cases to have all of the pipe pitch in the right direction, avoiding all "pockets" or bends that retard the flow of water.

CONCERNING BLOW-OFF TANKS

The blow-off pipes of steam boilers usually discharge directly into the open air; but it is not always permissible to dispose of the contents of the boilers in this simple fashion, and in many cases special tanks to receive the discharge have to be provided. This is especially true in cities, where the waste finds its way, ultimately, into the sewers. It is injurious to a sewer to blow the contents of a boiler into it directly, and many cities have ordinances requiring that an intermediate receptacle of some sort shall be provided, in order that the sewer may be protected from the destructive action of the direct discharge. It is objectionable, also, to fill the sewer with hot steam; and when tanks are provided they should be so constructed that they will permit the steam and water to separate, the steam being allowed to escape into the air through a vent pipe at some point where it will not constitute a nuisance, while the water is either permitted to flow from the tank into the sewer under the combined influence of gravity and such pressure as may exist within the tank, or pumped out of the tank when the conditions are such that the assistance of a pump is required.

When blow-off tanks are employed, it is exceedingly important that they should be made strong enough to withstand a considerable pressure. Too often they are regarded in the light of mere vessels which are to receive the contents of the boiler without being themselves subjected to any serious pressure. This is, indeed, the ideal function of a blow-off tank; and yet in designing such a tank we should always bear in mind the possibility of its being subjected to a pressure of some magnitude, through the occurrence of conditions that were perhaps not foreseen when the plant was installed. The neglect of this precaution has resulted in many serious accidents, often accompanied by loss of life.

A correct form of construction for a blow-off tank is shown in Fig. 1. This tank is built of steel, the sides being ⅜ inch thick, and the heads ½ inch. The shell is double riveted, and heads are bumped to a radius equal to the diameter of the shell. The blow-off pipe enters at the side, near the upper head, the opening for it being re-enforced by riveting to the shell a piece of plate ½ inch or more in thickness. The water that is discharged into the tank passes out again through a siphon which comes down to within six inches or so of the bottom of the tank, and is designated in Fig. 1, as the "outlet." The siphon is made of pipe 3 inches or 4 inches in diameter (the diameter of the blow-off being assumed to be 2 inches), in order that the water may have the freest means of escape. The elbow in the siphon is secured to a short nipple, which enters a bushing that is screwed into a re-enforced opening in the shell. Another piece of pipe, of diameter equal to that equal of the internal part of the siphon, enters the bushing on the outside, and leads to the sewer. A vent pipe, preferably 4 inches in diameter, at least, enters the upper head through a pressed steel flange, the collar of which is of sufficient length to afford a proper holding power to the threads on the end of the pipe. Finally, a manhole is provided, so that the interior of the tank may be readily accessible for inspection and repairs, and for the removal of such deposits as may accumulate in it.

In the engraving, we have shown the blow-off pipe as discharging directly against the siphon. This was done in order that we might show both the siphon and the blow-off distinctly. There is no serious objection to placing the two pipes in this manner, if the siphon is solidly constructed, so that it cannot be loosened nor displaced by the impact of the water from the blow-off. It is preferable, however, to have the blow-off and the outlet pipe enter the tank at right angles to each other.

We do not insist upon blow-off tanks having the particular design shown in Fig. 1, but we do insist upon their having a

strength amply sufficient to enable them to resist any pressure to which they may be exposed. The size and shape of the tank, and the sizes of its outlet and vent pipes, will naturally vary from one steam plant to another, the number of boilers in the battery, and the capacity of each, having a considerable influence upon these elements. Blow-off tanks are often placed underground, but we greatly prefer to have the tanks and their pipes so situated that they can be easily examined at all times.

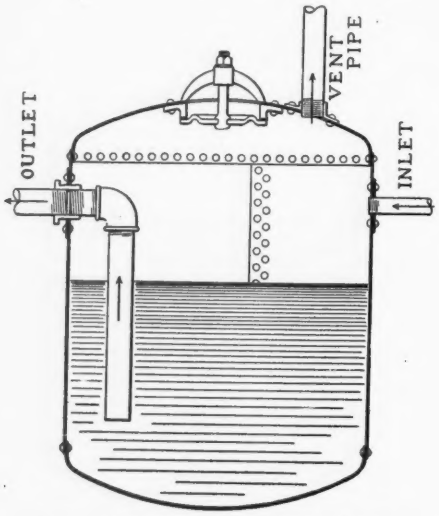

Fig. 1.—Correct Form of Blow-off Tank

As regards the intensity of the pressure that may exist in a blow-off tank, we can hardly say more than that it depends upon the sizes and lengths of the pipes, upon the size of the tank, upon the number and capacity of the boilers that may be blown off at the same time, upon the working pressure that is carried in the boilers, and upon various other circumstances. In a tank that is well designed, and adapted to the work that it has to do, the usual pressure, while blowing off, may be from 10 to 20 pounds per square inch, though it should be understood that this estimate is given merely for the information of those who have had no experience with such tanks, and that it does not pretend to represent the facts of general practice exceptin the very roughest way.

A boiler should never be blown off into a tank that is already full of water, or nearly so; for it is easy to understand that reduced in area, or possibly stopped up entirely.

the violent discharge of more water into such a tank is certain to produce a very considerable pressure, especially in the first few moments, before the flow out through the exit pipe has become fully established. It is hard to say how great a pressure might thus be produced, but if the blow-off were suddenly thrown wide open, so that the discharge, due to the full diameter of the pipe, could be turned instantly into a tank solid full of motionless water, it is probable that the initial pressure that would be realized in the tank, would be comparable with the pressure in the boiler, and it might conceivably be even greater. This fact, taken in connection with the known fact that a sudden load or pressure has twice the disruptive effect of an equal load when applied gradually, shows how serious the consequences may be, of blowing-off into a tank already full of water.

If the outlet of the tank should become partially or completely stopped up from any cause, the water from the boiler will accumulate in the tank, since its only means of escape would then be through the vent pipe, which, under normal circumstances, conveys nothing but steam. In many cases the vent pipe passes up to the top of a high building, and if the water in the tank should accumulate until it overflows through the vent pipe, it is plain that the tank may be exposed to a considerable pressure. For example, if the vent pipe were 100 feet high, and were full, the water within it would produce a static pressure upon the tank of something like 42 or 43 pounds per square inch; and this pressure would be realized, no matter how gentle the flow from the blow-off, the action here described being distinct from that contemplated in the last paragraph, where the pressure was due to the violence of the discharge into a full tank, without reference to the static head to which the tank might be exposed.

The vent pipe itself is also liable to become more or less completely closed, in winter in our northern latitudes, through the action of frost, particularly if the blow-off pipe leaks slightly. Small quantities of vapor, passing up through the vent pipe in cold weather, may give rise to a coating of ice about the free end of the pipe, and this may increase until the pipe is seriously

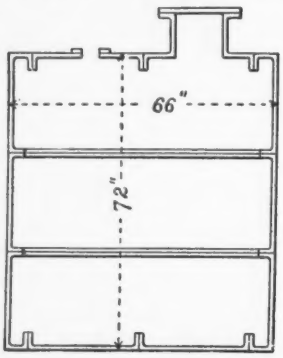

Fig. 2.—Vertical Section through Tank

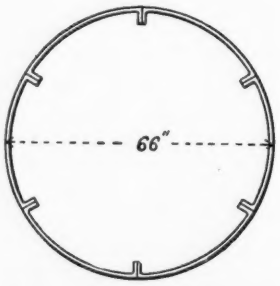

Fig. 3.—Horizontal Section through Tank

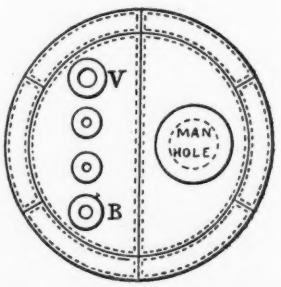

Fig. 4.—Cover of Exploded Tank

Whatever the causes of pressure in blow-off tanks may be, it is certain that such tanks explode, from time to time, owing to the existence within them of pressures not contemplated by their designers. By way of illustration, we give below an account of an explosion of this character, which occurred a short time ago in a steam plant that was supposed to be a model of its kind in all respects, and was described and illustrated as

such in the mechanical journals, shortly after its completion.

The plant in question contained five water tube boilers, numbered from 1 to 5. Nos. 1 and 2 were set together, and so also were Nos. 3 and 4; but Nos. 2 and 3, Nos. 4 and 5 were separated by alleyways. The blow-off pipes were each 2½ inches in diameter, and all were united into one 3-inch pipe, just before entering the tank that exploded; this tank being placed in front of the alleyway between boilers Nos. 2 and 3, and below the boiler-room floor. The safety valves on the boilers were set to blow off at about 130 pounds, and the pressure usually carried was about 125 pounds. The boiler room was considerably lower than the sewer, and the water blown off from the boilers was transferred from the tank to the sewer by means of pumps. The vent pipe, for the escape of steam, was 4 inches in diameter near the tank, but within a short distance it opened into a 5-inch pipe, which passed from the level of the boiler room up to a height of 7 feet above the roof of the building; the total height of the vent pipe being 110 feet.

The blow-off tank that exploded was 66 inches in diameter outside, and 72 inches high, the material being cast-iron. The shell was cast in sections, varying in thickness from ⅝ to ¾ inch, which were bolted together by means of flanges. The head was also of cast-iron, of the same varied thickness as the shell, and was made in two equal flanged sections, bolted together in the centre, the flanges being on the inside and serving as a strengthening rib. The manhole opening was a flanged frame in the form of a nozzle, 12 inches in diameter, 10 inches high and ¾ inch thick. There were four other openings in the head, 2 inches, 2½ inches, 3 inches and 4 inches in diameter, respectively, which were re-enforced by cast flanges. Only three of these four openings were used, the 3 inch one receiving the blow-off connection from the boilers, and the 4 inch serving for the attachment of the vent pipe, while the suction pipe from the pumps entered through one of the two others. The general construction of the exploded tank will be understood by reference to Figs. 2, 3 and 4; Fig. 2 showing a vertical section through the middle of the tank, and Fig. 3 a horizontal section acros the middle, while Fig. 4 is a view of the top of the tank, showing the openings for the attachments of the pipes.

The explosion occurred, according to our information, almost as soon as the blow-off began to discharge into the tank. The top head was torn off around the line of attachment to the shell, and was thrown into the air. One large fragment of the head, with the manhole frame attached to it, passed up between the two 6-inch I-beams that served as tracks for the coal conveyors, bending and spreading them so that they were forced against the 12-inch steam main, which was thereby ruptured, with the result that the steam from the entire battery of boilers was discharged into the boiler room. The only person in the room at the time was the fireman who opened the blow-off pipes on No. 2 boiler, the valve and cock on this boiler being found wide open, with the wrench on the cock. The body of the unfortunate man was found, after the accident, in the ash room, to which he had made his way through the clouds of escaping steam and water. Death was plainly due to the scalding, as he was fearfully burned fromm head to foot.

We cannot positively state the cause of this explosion, but we are of the opinion that the tank was full of water and that the failure was brought about by the shock that would be produced under these circumstances, as indicated in a nearlier paragraph of the present article. A float was provided to show the level of the water in the tank, and it was the practice in the plant to examine this float before blowing off, in order to make sure that the tank was empty. It appears likely either that the float did not work properly, or that the fireman forgot to examine it, so that he was not aware of the presence of water. We do not insist upon this particular explanation, however. Our main contention is, that blow-off tanks should be made strong enough to safely withstand any pressure to which they may be subjected through the failure of either the plant of the workmen to operate correctly, and the accident here described shows the soundness of this view of the case very forcibly.—*The Locomotive.*

Killed while Starting Gas Engine.

Louis W. Kirkland, employed at a confectionery factory in Pittsburg, Pa., had his skull crushed in the spokes of a fly-wheel on November 15th, and died almost instantly. Kirkland, with several other employees, was trying to start a gas engine in the ice cream manufacturing department of the establishment, and he took hold of the fly-wheel to throw it over. His head was between the spokes when the engine started suddenly, crushing his skull.

Appreciates Reading Matter.

EDITOR THE PRACTICAL ENGINEER:

Some days ago I received your check in payment for a short article I had sent you. I wish to thank you and must say that I was surprised, as it was such an ordinary article and so short that I never thought of receiving any payment for it.

THE PRACTICAL ENGINEER is certainly a practical paper, and so long as you keep it so, its success will continue. Such articles as that on page 5 of the August issue, entitled "Some Principles of Heat", are the most educating kind of reading matter and are well worth careful study, and there have been several other articles ranking close to it.

Grand Rapids, Mich. A. R. ERNSBERGER.

Pleased with Answer to Pump Question.

EDITOR THE PRACTICAL ENGINEER:

I was pleased with "The Way to Set Pump Valves", on page 23 of your October number. I have about twenty pumps from 4" to 20", and the valves are all set the way you explain and they run O. K. with never any trouble.

It is the first time I ever saw a rule published that did not cover about 14 pages, and when one had finished reading same he would feel like saying: "Where am I at?"

Newark, N. J. A. R. TALCOTT.

The power developed by a motor depends upon the product of the torque and the speed. A motor may be designed to run at a low speed and give powerful torque, or, a motor of exactly the same horse power might be built so as to give a small torque and run at a high speed. For some classes of work, low speed and powerful torque are required, while for other classes of work the opposite type of motor is found to be preferable.

The
Practical Engineer

DEVOTED TO THE ECONOMICAL GENERATION AND UTILIZATION OF POWER

PUBLISHED ON THE FIRST OF EACH MONTH BY

L. L. RICE

46 North Twelfth Street Philadelphia, Pa.

Correspondence solicited, and paid for upon publication. Short articles descriptive of the small problems met with in daily engineering practice are especially desirable. Illustrations prepared from pencil sketch.

Subscription Price, Fifty Cents a Year in advance to any Post Office, in the United States, Canada, Mexico or United States Possessions. One Dollar a year to other Countries.

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The Practical Engineer

46 North Twelfth Street PHILADELPHIA, PA.

The total circulation of The Practical Engineer for the year 1903 was 77,250 copies, an average of 6437 copies per issue. The total circulation for the year 1904 was 132,000 copies, an average of 11,000 copies per issue, The total circulation for 1905 was 182,500 copies, an average of 15,208 copies per issue.

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Long Distance Power Transmission.

The recent 66,000 volt transmission between Rogers Dam and Grand Rapids and Muskegon, Michigan, a distance totaling about 75 miles, recalls the progress made in long-distance transmission in this country since the time of the first transmission plants at Portland, Maine, and Housatonic, Massachusetts. Since the year 1894, when these two small plants were constructed, distances of transmissions and voltages on the lines have greatly increased, until now the record in both directions is 69,000 volts for pressure and 232 miles for distance. There are at the present time hundreds of plants operating at 20,000 volts and less, and about 125 plants operating at voltages higher than 20,000, and while 14 plants have been operating at pressures of about 60,000 volts, no plant attempted to poke its nose above the 60,000-volt line until the above-mentioned Grand Rapids-Muskegon transmission plant began operation. This plant was originally designed for 66,000 volts, but has recently been operated at 69,000 volts, and it has been in successful operation about six months.

In high tension transmissions of this character, the line is one of the most important features, since the transmission is useless if the line breaks down; but with the high voltage recorded, there seems to have been no extra trouble experienced. The principal trouble with high tension lines of this character has been to obtain good insulators and to protect the line from lightning. The latter is of the utmost importance, for where a line passes over fifty or a hundred miles of open country, dipping into a valley and rising to considerable elevations, all sorts of weather conditions must be constantly encountered. Thunder storms in summer are of frequent occurrence, and since the line will usually stretch across country, some part of the line may almost daily meet with some atmospheric disturbance.

The lightning protection of a transmission line is not against the strokes of lightning, but against the induced currents in the line caused by adjacent lightning strokes. Variation of atmospheric potential is also a factor which must be considered, as it has been found that a few hundred feet change of elevation will produce a potential variation of several thousand volts.

One of the most effective devices that has been used, and which is also used on the 69,000-volt transmission, is the erection of a continuous lightning rod along the entire line. For this purpose an iron wire is carried along on the poles and is grounded to them by burying a coil of copper wire in the ground.

When this arrangement is not used reliance is placed altogether on lightning arresters, through which the line may be grounded, these being installed either at the ends of the line or at both ends and intermediate points. These devices are either of the non-arcing metal type or of a type where the air current produced by an incipient arc between the parts of the arrester blows out the arc before the machine current has an opportunity of following and producing destruction, no mechanically operated lightning arrester ever being used.

These latter forms of lightning arresters, however, are only efficient for low voltages, and as the potential rises above 25,000 volts, some other method must be used. The final form of protection from this force of the elements has not been definitely decided, but the grounded wire arrangement seems to be as good as any of them; but it may be unsuccessful if voltages are forced still higher.

The question of insulators must also have to be met if voltages are to go still higher. For potentials up to 25,000 volts, where an insulator of seven inches diameter is sufficient, glass has been found to be sufficiently cheap and efficient, but for higher voltages porcelain is used. Insulators for high voltage lines must be very large, and in the highest voltage transmission insulators 14 inches in diameter and 18 inches high are used.

When the 100,000 volt transmission becomes a reality for long distances, it must have efficient insulators, satisfactory switches and dependable lightning arresters if continuity of service is to be maintained.

When the New Chief Takes Charge.

The crucial period in an engineer's life is when he is given charge of a plant which is new to him. The plant may be either new in design or construction, or it may be old but representing novel principles of construction; but of whatever nature he will be sure to find conditions and practices with which he is not familiar. It is during the first few weeks of his occupancy of this important office that the severest test of his ability will be had, and it depends more or less upon how he fills his predecessor's shoes during those first few weeks as to whether or not it will be his last few weeks at that plant.

There are two important things that must be studied—machinery and men. Perhaps the hardest of these to the thorough practical man is the thorough understanding of the employees under him. It is a hard matter to discharge a man who has been working at a plant for some years, and even though it appears that he is not performing his duties properly, it at once gives the suspicious assumption that he is exercising his authority unjustly, so that as a stranger it requires common sense and good judgment in handling men as well as the machinery. The principal index which will govern him in judging the men under him is the condition of the apparatus throughout the plant, the economy in the use of oil, fuel, waste and other supplies, the discipline and order which they show, and their past record and experience. These things, together with their "readiness to serve" factor, will determine the character of men with which he will have to deal.

The principal requisite of understanding the machinery is personal investigation. Starting with the boilers, he should follow every steam pipe to its destination, noting all the conditions pertaining to lack of economy, safety and convenience. About the boilers themselves he should know the diameter, length and number of tubes, width and length of grate, condition of internal and external surfaces, condition of brick setting, blow-off cocks, water column piping, safety valves and steam gauges, having the latter tested if necessary. In all cases nothing should be taken for granted, but everything looked up to his own satisfaction.

In the engine room all data pertaining to the engines should be obtained, and the condition of the interior of the cylinder and bearings noted. The exhaust lines should be carefully followed to the atmosphere or the condensers and the full particulars of heaters, condensers, vacuum pumps, grease extractors, back pressure valves and the like should be obtained. From the condensers and feed-water pumps the water-piping system should be studied, and special care should be exercised in noting the arrangement for emergencies and for fire protection. The application of the exhaust steam should be carefully studied, and if used for heating the system should be investigated. The generators and wiring should next have their share of attention, and the switchboard connections to generator and to distributing mains must be thoroughly understood.

Having mastered all of these details the next step should be toward improving the economy of the plant. Starting at the boiler room, the method of firing should be arranged to suit the fuel and conditions, boilers should be cleaned if necessary, feed water should be carefully regulated, and when possible boiler tests for economy should be run. Leaks and radiation are two obvious losses which all engineers will remedy as soon as possible, from which the attention should be turned to the steam-using apparatus, such as the engines and pumps. The indicator is here indispensable in order to find out if the valves are set properly; and all bearings should be re-scraped and the cylinder re-bored if found necessary. Any belts which may be used should be adjusted to prevent flapping or slipping, and they should carry the load without being too tight.

The economy of oil and supplies is one of the surest signs of the competency and efficiency of the man in charge of a plant, and the store-room where all supplies are kept should have the same careful attention paid to it as the other part of the plant.

To be able to keep the records of the operation of the plant intelligently, blanks should be provided which should be filled out daily, showing the performance of various pieces of machinery and giving all the information necessary in reference to coal consumption, oil consumption, character of load and machines in operation. Each chief engineer should design his own blanks, for every large plant contains a combination of apparatus peculiar to itself.

These are only a very few things which a chief must be able to do. No reference has been made to the diplomacy which is required when he is called to the front by his employers or to the arguments he must employ when making requisitions for new machinery or material, or to the judgment he must display when purchasing power plant apparatus and supplies.

Uneasy lies the head that wears the crown is a trite saying, but it is especially true of a chief engineer in a new plant; and perhaps for the first few weeks the head that wears the chief's cap does not have a chance to rest at all.

The speed of a motor increases or decreases when the brushes are shifted from their normal commutating point, because the shifting of the brushes alters the counter electromotive of the armature. If the brushes are in a position where the counter electro-motive force is a maximum and they are shifted either forward or backward, some of the armature coils will oppose the generation of the counter electro-motive force and thus reduce it. The speed will therefore increase until the counter electro-motive force again reaches its normal value.

To keep machinery from rusting, take an ounce of camphor and dissolve it in one pound of melted lard; take off the scum and mix the remainder with as much fine black lead as will give it an iron color. Clean the machinery to be treated and smear it with this mixture, and after a day or two rub clean with a soft cloth.

LETTERS FROM ENGINEERS

IN ORDER to make this department of THE PRACTICAL ENGINEER as interesting as possible, a moderate rate will be paid by us for all contributions published under this heading. However, we do not assume responsibility for the ideas or opinions expressed. None need hesitate to contribute because of inability to draw or write well. We will redraw or revise whenever necessary—it is the idea we want. New ways of doing old things, criticisms of accepted theories, and general engine-room experiences are especially solicited.

Cause of Cure for Mr. Arnold's Pump Trouble.

EDITOR THE PRACTICAL ENGINEER:

In the September issue, Mr. L. L. Arnold shows how he cured some pump troubles which are very interesting and he asks some of the readers to explain why those leather washers stopped the pump from short-stroking. If the condensing pump has the style of tappet arm that is shown in the illustration connected with his article, I will say that style gave me the same trouble some years ago, but as the cure I used was something different from his, I will try to explain why his washers had the effect they did on the valve motion.

The Deane condensing pump has three valves. The auxiliary valve which is connected to the valve rod which carries the tappets, admits steam to the piston valve that moved the main valve of said pump. Now, if the stuffing-box on the valve-stem is not kept full and with enough friction on it, the tappet-arm may rub on the rod and cause the auxiliary valve to shift the steam to the other side of the piston valve and reverse the pump when at half-stroke and would, as Mr. Arnold says, stop the pump, because the main valve would get in a position so that it could not give steam to the pump. If Mr. Arnold had taken those washers away from the tappets and had filled up or tightened his stuffing-box, he would have found that it would stop the pump from short-stroking.

The only reason I can see for the washers having the effect they had is that his valve rod was worn where it ran in the stuffing-box, and when he put washers in front of the tappets, it drove the rod far enough so that the shoulders of the rod caught in the packing and had the effect of tightening or screwing up on the stuffing-box.

I will say that the Deane pump is not the only condensing pump of the independent pattern that sometimes gives the same trouble, and I would like to hear some other engineers' views on this pump trouble.

Fall River, Mass. M. H. H.

Short Rules for Finding Saving Due to Heating Feed-Water.

EDITOR THE PRACTICAL ENGINEER:

In the October number E. S. Hawkins answers some questions put to O. F., when he applied for a hoisting engineer's license. I hope O. F. understands the answers to question No. 6. To me it is clear as mud, but it may be because I am young in the business. I would like to know how he found that there would be 9.7 expansions from the data given in the problem. I always thought that to find the number of expansions, you would have to know the cut-off. I hope some one will explain this clearly.

In reference to question No. 7, there is a rule I use for finding the amount of coal saved by raising the temperature of the feed, which is near enough for all practical purposes and which can be easily remembered. The rule follows: Divide the difference in temperature of the feed by 1100 and the result is the per cent. saved; multiply the result by the original coal consumption and the result will be the pounds of coal saved. For instance, taking question No. 7, in which 12000 pounds of coal are used when the feed is 45 degrees and it is required to find how much coal is saved when the feed is raised to 100 degrees, according to my rule, $100 - 45 = 55$ and divided by 1100 gives 5 per cent. as the saving, or $12000 \times .05 = 600$ pounds of coal saved.

New Bedford, Mass. J. E.

Rough Calculations for Finding the Number of Pounds of Steam Required by an Engine per Horse Power per Hour.

EDITOR THE PRACTICAL ENGINEER:

The question was asked: "How many pounds of steam will a 15¼" x 24" engine, running at 177 revolutions per minute, 90 pounds boiler pressure, and cutting off at ⅛ stroke, exhaust per hour?"

As the arithmetical and approximate method of handling such problems may be of some interest to the readers of THE PRACTICAL ENGINEER, I offer the following solution:

The only way that I know of whereby the exact quantity of exhaust steam could be found, is to make an actual test at the engine itself; for, given two engines of the same size, etc., but running under different conditions, the quantity of steam exhausted will be different in each, hence the necessity of a test of accuracy is desired. For ordinary, every-day purposes, arithmetical calculations, based on certain data, and possibly making assumptions as well, will serve. Such calculations will give a general idea, and when allowances are made are sufficiently close.

In such problems as we are considering, especially when used for illustrative purposes, as at present, clearance, size of piston rod and losses due to condensation and radiation of heat are neglected, and thus complications are avoided.

As the boiler pressure is stated as 90 pounds per square inch, the absolute pressure is $90 + 15 = 105$ pounds. Strictly speaking, the figure should be 14.7 instead of 15. Roughly speaking, the pressure of the atmosphere is quoted as 15 pounds per square inch at sea level; the steam is cut off at ⅛ stroke, which means 3 expansions (when clearance is ignored). The terminal pressure in the cylinder under 3 expansions and one initial pressure of 105 pounds absolute will be: ⅛ of 105 = 35 pounds absolute. In actual practice there would be the losses referred to, and so a terminal pressure of 35 pounds absolute would not be realized. How much less it would be would depend upon a number of conditions, and could not be exactly foretold. An indicator diagram from the engine would show just what the terminal pressure would be, but the diagram would not show how much condensation took place during a stroke.

There will be a cylinder full of steam at 35 pounds absolute pressure exhausted at every stroke. By referring to a steam table (contained in most pocketbooks and frequently in catalogues) we find that the weight of one cubic foot of steam at 35 pounds absolute is .08576 pounds.

The engine runs at 177 revolutions per minute, or $177 \times 2 = 354$ strokes per minute, and $304 \times 60 = 21{,}240$ strokes per hour. Next we find the volume of the cylinder. Diameter, 15¼"; area $= 15.25^2 \times .7854 = 182.65$ square inches; the length is taken as 24", so that $24 \times 182.65 = 4383.6$ cubic inches, or $4383.6 \div 1728 = 2.5362$ cubic feet volume. This is the number of cubic feet of steam exhausted per stroke, and $2.5362 \times 21240 = 53864.64$ cubic feet of steam exhausted per hour. Multiplying this by the weight of 1 cubic foot at 35 pounds absolute terminal pressure, we have: $53864.64 \times .08576 = 4619.43 +$ pounds per hour.

Suppose the engine is developing 200 horse power, then by taking an even number, say, 4,620 pounds exhausted per hour, $4{,}620 \div 200 = 23 +$ pounds steam per horse power per hour.

Make an allowance, say, of 25 per cent., and we will have approximately 30 pounds per horse power per hour, which is about what would be expected from the kind of engine in the problem.

Scranton, Pa. CHAS. J. MASON.

Something About Gaskets.

EDITOR THE PRACTICAL ENGINEER:

A short time ago I was sent out from the shop where I am employed to overhaul a small pumping engine, and one of the many interesting things that I was called upon to do was to take off and replace several of the cylinder heads and steam-chest covers. The pump that I overhauled was a triple-tandem, compound duplex condensing engine, having cylinders 10" x 16" x 28", plunger 13" in diameter, with a common stroke of 24". The pump being of the inside packed type, the repair work consisted principally of replacing broken piston-rings and ring dowels, examining piston-lock nuts, replacing bent and scored valve rods, and furnishing new tappets for the valve gear. Of course, it has always been customary for me to look over the ground before I begin to tear down a pump or an engine, and ascertain if there is ample packing to make any necessary gaskets or fill any emptied stuffing boxes. In this case I found the cupboard well stocked with piston-rod and valve-stem packings, also an abundant supply of plunger packing, but very little sheet packing of any kind.

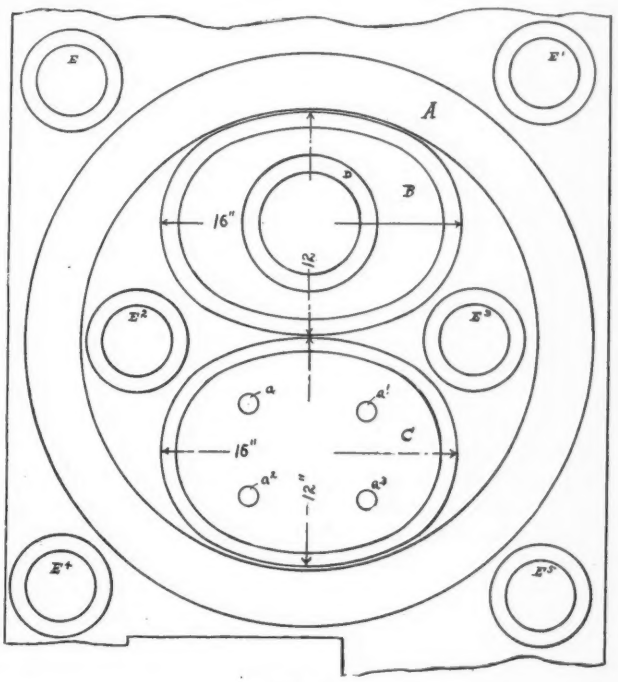

Fig. 2.

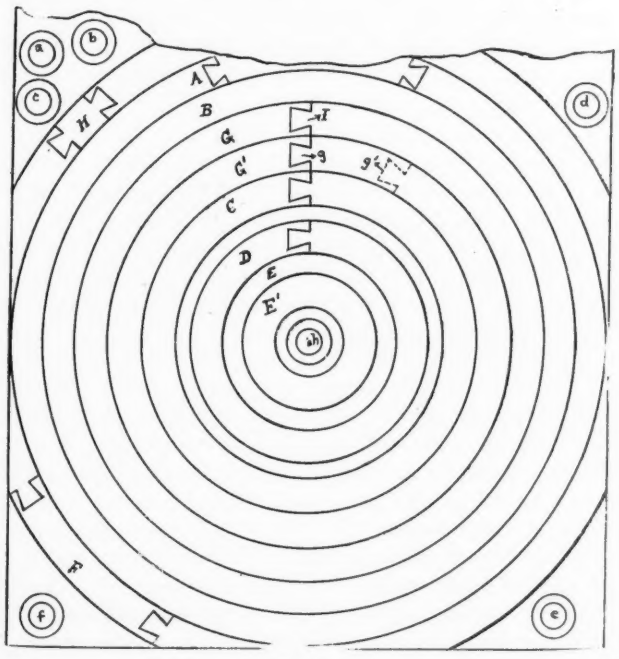

Fig. 1.

After a thorough search I managed to dig up a piece of 1/32" sheet packing about 36" square, suitable for steam joints, and a piece of ⅛" three-ply sheet packing 36" wide by about 80" long, suitable for gaskets for the condensers and water pipes. As I measured the piece of 1/32" sheet rubber and found it to be but 36" square, I asked the engineer if he wanted anything done to the reserve pump, and he said that its low-pressure cylinder head had to come off to repair the flange face of the jacket space. It needed a new copper plug or something of that sort. "You'll have to bring out more sheet rubber", said the engineer; but according to the accompanying sketch in Fig. 1 is shown quite plainly how I managed to get out the several gaskets that were needed for the steam ends of the pumps. At B, Fig. 1, is shown the gasket cut for the outboard head of the low-pressure cylinder; at A is shown a gasket taken off the outside diameter of the gasket B, and at H is shown the dovetailed section used to join the two ends of the gaskets, A. The gasket, G, being cut at I, was made to fit the low-pressure head that was removed from the reserve pump, by applying the section shown at F. The section G^1 was cut in two at g, and it was necessary to cut out the portion between g and g^1 at the dotted lines to get it to conform to the size of the gasket shown at C, which is the size of the intermediate cylinder head. The gasket shown at D was used for one of the high-pressure cylinder heads, and the one shown at E was reserved for a steam cylinder head of an air compressor in the plant. The gasket at E^1 came in very handy, when we removed the heads of the cendenser; this gasket

fitted a flanged connection on the exhaust line from one of the large pumps. The small gaskets shown at a, b, c, d, e, f and h are for several 1½" flange unions that were leaking about the plant.

After we had quite thoroughly completed the steam end repairs and replaced the heads, etc., I turned my attention to the water end. In removing the water-cylinder heads, both gaskets were so rotten that we concluded to put on new ones, so after studying out the problem I cut the water-end gaskets as shown in the accompanying sketch, Fig. 2, at A. At B and C are shown two 12" x 16" boiler manhole gaskets that were cut from the centre of each of the two water head gaskets. The gasket at D being for a special hand-hole plate in one of the condensers, and the gaskets shown at E E^1 E^2 E^3 E^4 E^5 are for a smaller sized hand-hole plate flange of which there are several on each of the condensers. The four holes a a^1 a^2 a^3, shown in the four quarter sections of the blank of the manhole gasket at C, represent the bolt-holes where the gasket fits the bolts that retain the 12" x 16" manhole plates in the boiler.

The number of gaskets that I succeeded in getting from the two pieces of sheet packing were quite a surprise to the engineer, as was also my method of retaining the gaskets on the steam cylinder without the use of a thread or sewing the joints together. I used a small bottle of liquid, bicycle-tire cement on one side of the gaskets, and a liberal supply of graphite and cylinder oil on the other side, and each and every gasket that I put on held nicely.

Depew, N. Y. C. W. D.

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What Does the Public Care About the Theoretical Knowledge of an Engineer? Safety is what They Want.

EDITOR THE PRACTICAL ENGINEER:

I have been greatly interested in the examination questions and the comments thereon, published from time to time in your valuable paper. Permit me to say a few words. I fully indorse the articles by A. K. V. and E. S. H., in the September issue.

As I understand the license law for engineers, the primary object was to better protect the public by having more competent and intelligent men in charge of steam boilers and steam machinery; to prevent, as far as possible, by better and more intelligent management, the occurrence of some, if not all, of these terrible boiler explosions. It looks to me, judging from the list of examination questions asked by some of the examiners, that the main object has been lost sight of entirely and the examinations are merely a list for a man's theoertical and technical knowledge.

I believe the questions asked an applicant should deal directly with the successful operation and management of such plant. Do not ask him to design new machinery for such plant; that is not his part of the program. If the examiners are the right men in the right place, they can soon get a good line on the ability of an applicant to handle such plant without going into details to test his technical knowledge. Of course, some men can tell more than they know in a short time, others cannot tell things, but can do them. If some of the questions submitted are only practical, when will you get the theoretical? For instance, the problem of the 2000 horse power high-pressure compound-condensing engine, Mr. Rhoades says, gives the applicant a chance to show that he knows. I suppose the public safety would be better protected by having such a man in charge of all steam plants.

What do the public know, or what do the public care; in fact, is it any of their business anyway whether an applicant can construct theoretical indicator diagrams, know all about logarithms, coefficients of expansion and friction, properties of saturated steam, ratio of volumes, best points of cut-off, best compression and steam consumption? If the applicant is so fortunate as to possess a knowledge of these subjects, so much the better for him, but it is of no interest to the public.

If an applicant can satisfy the Board that he is a sober, careful and competent man, and understands the care and management of his boilers and pumps and appliances pertaining to a steam plant, I say he is entitled to a license. I think it is unfair to turn a man down, prevent him from earning a livelihood in his chosen profession, simply because he could not answer a lot of questions that would make a college professor guess some.

How many applicants do you suppose could draw the combined theoretical cards for a compound engine, give the points of cut-off, terminal pressures, internal and mean effective pressures, etc., and do it in the time allotted for such examinations? And yet that question was asked an applicant a short time ago. He did not answer it then. Possibly, many could do it if they could take the question home and, having a good library at their commands, retire to the privacy of their dens and figure it out. Suppose he could do all this, would he be of any more value to his employer than a man who could operate this plant successfully, economically, intelligently, get results from every pound of coal consumed and every gallon of water evaporated?

The average operating engineer is not called upon to design his machinery, but to operate such as he has to the best of his ability. Being the proud possessor of a first-class license does not always fit a man to cope with all the troubles encountered in the boiler room. One instance in our town was a man holding a first-class engineer's license issued by the city of Detroit. This man could not make good in a 150-horse power plant. He could not keep his boilers hot, but succeeded finely in keeping everything else about the plant hot, even the manager. The man in charge of the plant for the last six years never saw a license and, perhaps, never will, yet he has operated the plant satisfactorily to the management for that time. We have no State License Law in Michigan, but hope to have some day.

I believe in a Board of Examiners composed of good, practical men, no politicians, men of sound judgment, men that fully understand and know the requirements and qualifications necessary for good engineering, men who would not get a "swelled" head because they held an important position.

Have a list of questions prepared along the lines that A. K. V. submits in his article in the September issue. I believe under such conditions a license law would prove invaluable both to the engineer and the public in general. I am in favor of a license law, a law that will protect the hard-working, studious engineer, the man that wants to and tries to better his condition, educates himself to fill a better position, to command a better salary in his chosen calling. There is no reason why any person that can read cannot improve himself mentally. Be fairly well informed upon the questions of the hour pertaining to his business. Good books are cheap; he can have a good library for a comparatively small amount of money.

Papers and magazines are within the reach of all, yet how many men there are that have neither, and yet they wonder why the other fellow can get and hold a better job than they can. It has been wisely said—a person must either advance or retrograde in his calling, he cannot remain stationary.

Theoretical knowledge and the theoretical man are useful; we must have them.

Practical knowledge and the practical man we must have also. Combine the two in the proper proportions and the combination is useful; otherwise, it is a failure.

Quoting from E. S. H., would say with him: "Take advantage of every opportunity for advancement. Get all the theoretical and technical knowledge we can, but do not use it or let it be used to put one less fortunate but equally capable brother out of business."

Milford, Mich. T. F. S.

Leather Washers Prevented Valve Springing Ahead.

EDITOR THE PRACTICAL ENGINEER:

In your September issue Mr. L. L. Arnold states that his pump worked with leather washers in front of the collars when shifting the collars themselves did not remedy the trouble, and he therefore calls it a seming freak.

Now, my opinion is that the rocker arm and the collars, both being of hard metal, made the valve spring ahead of its proper position when the piston moved ahead, thus changing the position of the valve to the opposite stroke, or, in other words, reversing the pump before the end of the stroke, causing it either to short-stroke or to stop.

When the leather washers were put on the leather acted as a cushion for the arm to strike against, and thus remedied the trouble by preventing the valve from springing ahead.

Rhinebeck, N. Y. P. R. A.

Trouble with Belts and the Remedy.

EDITOR THE PRACTICAL ENGINEER:

I once took charge of a plant that included in its equipment a good sized centrifugal pump. The driving belt of this pump was of double leather, 10 inches wide, and as the drive was a vertical one, the belt had to be kept very tight to make the pump deliver the goods. It was driven from a counter shaft

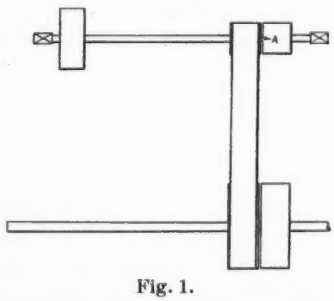

Fig. 1.

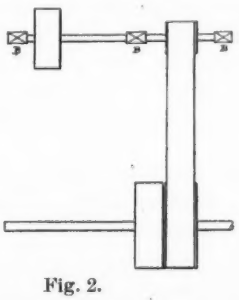

Fig. 2.

3 inches in diameter, that was in turn driven from the main line shaft by a 12-inch belt running on tight and loose pulleys.

As this whole rig was at a distant point from both engine room and machine shop, it did not receive as much attention as might have been given it under other conditions and when I took the plant, the loose pulley could be heard for a block when the belt was shifted upon it. Whenever that particular department was at work, the pump had to run, so the loose pulley did not have much business most of the time.

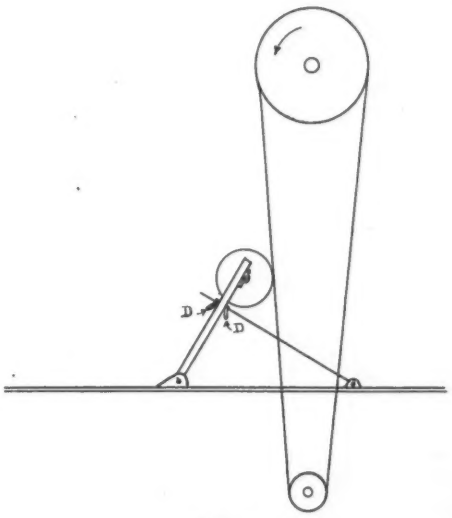

Fig. 3.

Fig. 1 shows the plan of this drive as it was until one afternoon, when without any preliminary warning the shaft broke between the tight and loose pulleys at A. Then I changed it so as to avoid the loose pulley entirely, moving the pulleys further along on both shafts and using three hangers on the counter-shaft as at B, Fig. 2. This change kept the pump running all the time when the main engine ran, unless the belt was thrown off, which could be done in case of long stops in that department.

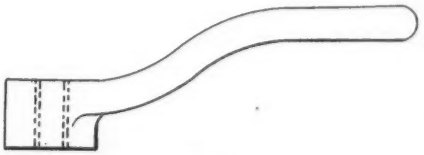

Fig. 4.

Then the tightener shown in Fig. 3 was built and from that time on, we had no more trouble with our centrifugal pump. The tightener frame had two rods running down to the floor provided with hand nuts, D, D, shown in detail in Fig. 4. With a long thread on each rod, it was easy to adjust the tightener in any position required. The frame was of wood and was slotted for the rods.

E. Greenwich, R. I. L. L. ARNOLD.

Illinois Examination Questions for Hoisting Engineers.

EDITOR THE PRACTICAL ENGINEER:

The following questions were asked the candidates for certificates as Hoisting Engineers, by the Illinois State Mining Board, in the recent examination given at Springfield, Ill., on October 15th. The first three questions pertain to the laws of the State in reference to the duties of the hoisting engineer, in reference to persons going into the engine house, and in reference to the care of engines and boilers. The other questions follow:

1. How would you prepare a boiler for cleaning?

2. Should the friction brake and the brake wheel required for an engine at a sinking shaft be placed on the shaft of the engine or on the rope reel to hold the bucket secure at any point in the shaft?

3. Give the signals prescribed by law.

4. What thickness must the steel be in a cylinder boiler to stand the pressure of 100 lbs. per square inch. The boiler is 48 inches in diameter, allowing 1-6 for safety, tensile strength of steel 60,000 lbs. per square inch?

5. What is the indicated horse power? Give data.

6. With water at a temperature of 40° F. would you use a feed pump or an injector?

7. We wish you to put us in a boiler to give 120 horse power, the boiler to be 16 feet long and 6 feet diameter. If a cylinder boiler, say cylinder; if a flue boiler, say flue; if a tubular boiler, say tubular. Give number and size of tubes, number of feet of heating surface, gratebar surface, kind and size of safety valve.

8. We are putting in a pair of compound engines. We are using a boiler pressure of 120 lbs.; our low-pressure cylinder is 48 ins. by 32 ins. What size cylinder would you have for your high pressure?

9. Give the breaking strain of 11-16 plow steel wire rope; also safe working load.

10. We have a tank full of water in the morning when we commence work; we are using 1,300 horse power per hour; how long will it take to empty tank? The tank is 8 feet diameter and 12 feet deep.

11. We have a circular tank full of water; the tank is 12 feet diameter on top, 15 feet at the bottom and 15 feet deep. The water in the tank is 100° F., how much coal will it take to evaporate the water into steam?

12. The belt wheel on a dynamo is 2 feet diameter and runs at a speed of 600 revolutions per minute. The belt wheel on the engine is 14.5 feet. What speed must the engine run?

Breese, Ill. O. F.

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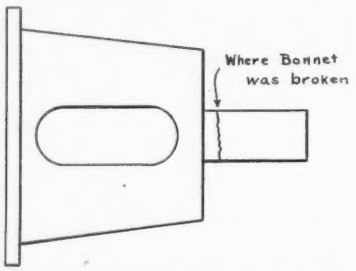
Broken Bonnet Caused Sticky Valve.

EDITOR THE PRACTICAL ENGINEER:

Referring to page 21 of the June issue, in regard to four good reasons for sticky valves, I wish to say that it is not always poor lubrication, defective dash-pots, drawing packing too tight on the valve stem or improperly adjusted air valves, which cause sticky valves. There are several other reasons, one of which happened in a power house where I am employed.



Broken Bonnet on Corliss Engine

In the power house there are several engines of both the high- and low-speed cross-compound Corliss type. One evening, the dash-pot on the high-pressure side of a low-speed engine failed to drop for several revolutions, then seemed to work all right again and then again failed. Thinking it was caused by poor lubrication, I pumped oil in the valve chest, but it failed to remedy it. The engineer then took the plunger out of the dash-pot and upon examination nothing was found to be out of order. Upon examination of the releasing gear, the bonnet was found broken, as shown in illustration, which jambed between the other part of the bonnet and valve lever or "Jim-crank", as it is sometimes called. After we repaired the break and had the engine going again, the valve closed O. K.

Northampton, Va. C. M. G.

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Experience with Feed-Water Regulators.

EDITOR THE PRACTICAL ENGINEER:

There are three important points in the operation of steam boilers that make a steady feed and constant water level a desirable thing.

First.—Relief from strains. When the water level changes frequently for any considerable amount, the weight of water changes, and has something of the effect of placing a lever on it and subjecting the metal to different strains and crystallizing the same. In a shell boiler six feet diameter and twenty feet long, a difference in level of four inches makes a difference in weight of about a ton.

Second.—Economy and strains. The economy of a boiler will depend somewhat on its circulation. When the circulation is free, the economy of a boiler will be at its best, as the heat at that time is taken up the most rapidly. Should an extra amount of feed be turned on, the circulation will be checked and the economy decreased. There will also be strains set up, because of the difference in temperature. When the feed is constant and just the amount that is required, the circulation will take up the largest amount of heat without strains from unequal temperature or weight.

Third.—Cleanliness. Take a shell boiler, for example. When the circulation is in good shape, the deposits are carried to the top of the water to the rear end and dropped near the blow-off. Should the feed be turned on strong, as in hand regulation, the circulation is checked and dirt is deposited over the entire length, and in *most* cases is turned on, which explains why a boiler which is fed just enough will be clean, while another under exactly the same conditions, except that the feed is irregular, will be in bad condition, so that an apparatus that would feed a boiler constantly, that had nothing about it to get out of order and nothing to stick, would be a valuable acquisition.

In 1864 the writer had some experimenting to do with a boiler feeder. This consisted of a globe, in the centre of which was a tube and long piston. This globe was supported on one end of a lever with a weight at the other. When the globe was full it was in communication with the boiler in such a manner that the steam was admitted to top of the water in the globe when the water in the boiler was below a predetermimned water line. When the globe was emptied it would rise, shutting off inlet to boiler and connect with tank above, fill and reutrn to feed the boiler. This kept a uniform water level, but the trouble was to keep the packing tight in the central tube and not have it stick. It was finally abandoned.

The next one I had experience with was in 1872. This was of the usual type; it regulated a feed valve in the feed pipe, and when the packing on stem got hard or was screwed a little tight, there was trouble, and this was abandoned. A year or two later another was tried, but this had a valve stem that required packing, and was abandoned.

In 1905 my attention was called to a feed water regulator that was free from the above objections, as all parts were enclosed and self-contained, and there was no occasion for packing on any moving part. This was tried and gave no trouble, but was always doing its work properly when left alone. These regulators were put on water tube boilers that had superheaters.

Steam cannot be superheated until thoroughly dry, and heat must be absorbed in a superheater until the steam is dry before superheat will take place. These boilers were not driven very hard, so the superheat was not very great. The temperature of the steam was taken before the regulators were applied, and the log showed the result of hand regulation. It was noticed that the superheat was low, and investigation showed the water nearly at the top of the glass gauges. During the test a man was stationed to keep the water at the lower gauge, which would bring the water about four inches below the centre of the drum.

After the regulator had been in use about nine months another trial was made with good results, although at this time the damper regulator stuck some and the firemen were not so good as in the former trial; but the feed regulators gave a good account of themselves and increased the superheat.

In both cases an extra engine was cut in at about 6 o'clock and there should be a little more superheat, as the fires were hotter. This was shown with the feed-water regulators, but not with hand regulation. With the feed-water regulators the water was kept at centre line of drum.

With a feed-water regulator that has nothing about it to stick, this apparatus becomes an important attachment to any steam boiler.

Waterbury, Conn. W. E. CRANE.

The Massachusetts License Law Again.

EDITOR THE PRACTICAL ENGINEER:

I have been watching the columns of your valuable paper to see if any of my fellow-workmen would have the courage to call attention to the gross injustice which will be done under the latest amendment to the Massachusetts State Engineers' License Law, which will affect those engineers in Massachusetts who got a second-class license under the simple and practical examination that was in vogue some time ago, but who are now shut out from obtaining a first-class license by the technical examinations that are being handed out by the examiners. Here is the amendment: "A person holding a fireman's or engineer's license, who desires to have charge of, or to operate a particular steam plant or type of plant may, providing he hold an engineer's or fireman's license, if he files with his application a written request signed by the owner or user of said plant for such examination, be examined as to his competence for such service and no other, and if found competent and trustworthy, shall be granted a license for such service and no other. No special license shall be granted to give any person charge of a plant of over 150 horse power." Now, I believe that this is one of the most selfish pieces of legislation that has passed the Massachusetts State Legislature; for, why in the name of common sense and justice is it not right to give the second-class men the right to have charge of an engine over 150 horse power, if it is right to give a fireman a license to have charge of an engine of 150 horse power? Also, the second-class license grants permission to the person licensed to have charge of any number of engines of 150 horse power and any number of boilers of any horse power. Surely, if he is intelligent enough and competent to do this, he ought to be allowed to have charge of and operate a condensing engine of about 1,000 horse power. It seems to me to be a wrong idea to say that a few men who have secured first-class licenses, but who are not able to fill all the positions that are open, are going to prevent other good practical men from filling them simply because they don't come up to their ideas of what an engineer should be. I believe in education, but I don't believe in seeking any undue advantage by it at the expense of any of my fellow-engineers, as a few of the educated ones seem to be doing.

The first-class license men have nothing to fear if they are good practical men and able to operate a plant as well as to design one. True merit will always come out on top and requires no special legislation to keep it there.

To show the gross injustice that may be done, I will just state one likely case. I know a young man who had charge of and operated a 500 horse power, cross compound engine for over four years. He left it to accept a better position under a chief engineer; now we will suppose that he wishes to go back again and that the position is open for him; he cannot do so, for the law forbids him, although he operated that engine to the satisfaction of his employers and left it in better condition than what it was when he took charge. I believe, also, from reading THE PRACTICAL ENGINEER and my observation from other sources, that there are not 10 per cent. of the engineers in the State of Massachusetts who have obtained first-class licenses who could answer the six questions given by me in the May issue, and I also challenge R. D. and others who think that the questions are perfectly practical and proper, to answer them if they can, sending in the work to the editor as an evidence of good faith, that the answers were not merely copied from some book, as I believe M. H. H.'s were. I also think that there are other ways for finding out if a practical man can reason, not without asking him to use hyperbolic logarithms which he may not require to use again in a thousand years.

If anyone wants a simple rule to figure the receiver gauge pressure of a compound engine, try this: Square the diameters of both cylinders, multiply the square of high-pressure cylinder by the initial pressure, divide the product by plus the squares of both cylinders, then subtract the pressure in the condenser. The result will be the approximate receiver pressure, which will vary according to the load.

I would just like to say, in closing, that I hope that with the advent of the chief inspector, we will have a just and honest administration of the law.

Fall River, Mass. J. R. R.

Turbine engines are still on trial. The Hamburg-American Company declines to adopt them yet, and President Ismay, of the International Mercantile Marine Company, says that his Company will soon build six steamers, some of which will be second to none in speed and elegance, but none of them will have turbine engines.

QUESTIONS and ANSWERS

THE editor will be glad to receive from the readers of THE PRACTICAL ENGINEER, such questions relating to engineering subjects, as may, from time to time, occur to them. All questions and answers should be addressed to the editor and accompanied by the name and address of the writer, which will not be published, however, unless especially desired. It is the intention that questions shall be answered by the readers, and even though the editor may, from time to time, publish answers and questions, he especially desires the readers in such cases to contribute any further information, in connection with the points raised, that they may consider of interest. All questions and answers received by the editor will be published, as far as practicable, but he reserves the right of editing or rejecting any communication.

Storage Battery.

EDITOR THE PRACTICAL ENGINEER:

Will you kindly give directions for constructing a storage battery of sufficient capacity to burn five or six 16 candle power lamps, 14 hours? I wish battery to occupy the smallest possible space consistent with efficient service.

Detroit, Mich. B. C. S.

The construction of a storage battery is a more or less difficult operation as it involves a great many constructive details which are usually the result of practical experience. The simplest form of storage battery can be made by taking two sheets of lead; these are laid flat one above the other with a non-conducting substance such as India rubber between them. The two plates with the intervening insulating strips are then rolled up into a spiral; the plates must not touch. They are then immersed in a 10 per cent. solution of sulphuric acid, one lead plate is then connected to one terminal of a direct-current circuit and the other plate to the other. It will be noticed that one plate will become red and the other plate will become spongy lead. After the battery has been charged for a certain length of time, it can be discharged and the voltage will be about 1½ at the start but will quickly fall to 2 volts after it has been discharged a short time. Just how many lamps or what the capacity of such a cell would be depends upon the size of the lead sheets used. In practice the leaden plates are made up in a form of grids so as to get more active material in the cell.—[Ed.]

Flow of Water into a Vacuum.

EDITOR THE PRACTICAL ENGINEER:

Will you kindly answer these questions through your paper when convenient?

1. At what velocity will water flow into a vacuum?

2. At what velocity will water flow into a vacuum 10 feet higher than the water?

3. What would be the velocity of 1,000 gallons of water passing through a 4-inch suction pipe in one minute?

4. Is the atmospheric pressure sufficient to force 1,000 gallons of water through a 4-inch pipe in one minute?

Media, Pa. A. S.

1. The atmosphere, having a uniform pressure of 14.7 pounds per square inch, is equivalent to a head of about 34 feet when acting on a vacuum; so that the theoretical velocity of flow under this head would be 46.75 feet per second.

2. If the water had to overcome a head of 10 feet when flowing into a vacuum, the theoretical velocity would be 39.3 feet per second.

3. Since there are 7.48 gallons in one cubic foot, 1,000 gallons is equivalent to 133.6 cubic feet, and to find the velocity of the water for one minute, this quantity must be divided by the area of the pipe in square feet. The area of a 4-inch pipe is 12.5664 square inches or .0871 square feet, so that the velocity is equal to 1,534 feet per minute, or 25.56 feet per second.

4. The equivalent head corresponding to any velocity is obtained by dividing the square of the velocity by twice the force of gravity, or 64.4. In this case the square of the velocity is 653.3, and dividing by 64.4 gives a corresponding head of 10.15 feet. Therefore, the atmospheric pressure of 14.7 pounds per square would be sufficient to force 1,000 gallons of water through a 4-inch pipe into a vacuum, provided, of course, that no other conditions enter into the problem.—[ED.]

Horse Power of Engine.

EDITOR THE PRACTICAL ENGINEER:

What is the horse power of a 22 x 48 non-condensing engine running 81 revolutions per minute, cutting off ½ stroke, boiler pressure 80 pounds? I have used the formula PLAN ÷ 33,000 and get 380 horse power but brother-engineers say I am wrong.

New Haven, Conn. K. H. J.

The value of P in the horse power formula should be found from an indicator card, as it depends upon the initial pressure, cut-off, release, back pressure and compression of the steam in the cylinder; otherwise it can only be approximated. Assuming that the mean effective pressure is about 50 pounds and substituting the proper values in the horse power formula, $50 \times 4 \times 380.13 \times 162 \div 33{,}000 = 373$ horse power which closely corresponds to your result. Of course, if the mean effective pressure is different, the horse power will be different. —[Ed.]

Throw of Eccentric. Joy Valve Gear.

EDITOR THE PRACTICAL ENGINEER:

If the eccentric of an engine had a 4-inch throw and that opened the port wide open, what effect would it have on an engine to take it off and put on an eccentric with a 5-inch throw in its place?

Does not the throw of the eccentric equal the travel of the valve?

Explain the Joy valve gear.

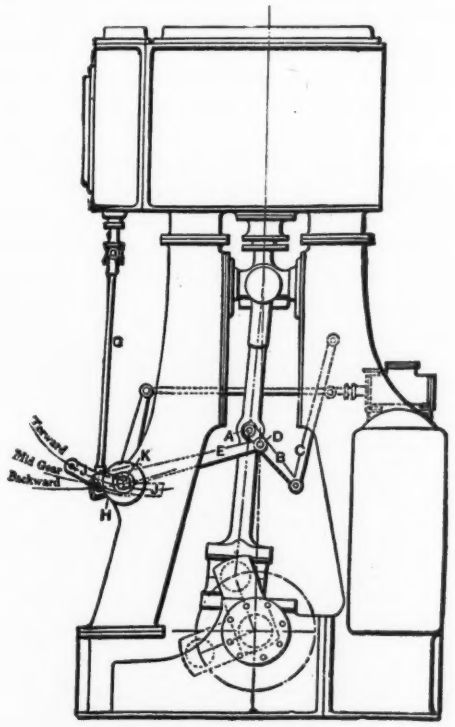
Drew, Maine. E. I. L.

The effect of increasing the throw of the eccentric would be to increase the travel of the valve. If the dimensions of the valve were not changed, and the valve chest permitted the increased valve travel, the effect of increasing the throw of the eccentric would be to admit steam earlier and cut it off later and the valve would have more overtravel.

The distance between the centre of the eccentric sheave and the centre of the shaft is called the throw of the eccentric, so that the valve travel equals twice the throw of the eccentric, just the same as the travel of the piston equals twice the throw of the crank. This is assuming, of course, that the valve rod gets its motion directly from the eccentric rod.

The Joy valve gear is a radial type of reversing gear in

which the motion of the valve is taken from some point in a vibrating link, one end of which moves in a closed curve, while the other point moves in a straight line or open curve. The closed curve is usually a circle, an oval or an ellipse. The accompanying diagram shows the valve gear applied to a marine engine. It will be seen that the motion originates from a point A on the connecting rod which gives from its connection to a secondary link B, a reduced motion to the lever which drives the valve stem G. The point D, therefore, describes an oval. The other end of the link E slides in a curved path JJ. The reversing effect is caused by changing the angle at which the curved slot is inclined. A variation in the point of cut-off is produced by the variation in the throw of the valve-stem, which is least when the curved slide is mid-way between its forward and backward position. The slide is often replaced by causing the point K to vibrate from its connection to a link.



The Joy Valve Gear

The Joy valve gear is thus made up entirely of pin joints for the moving parts and gives equal lead, cut-off and port opening for all positions of the gear. The advantages of this class of gear are that it does away with one or both of the eccentrics which in fast running engines are sources of friction and are liable to cause trouble by heating.—[Ed.]

Horse Power of Belt. Saving Due to Heating Feed Water. Strength of Beam.

EDITOR THE PRACTICAL ENGINEER:

Will you kindly answer me the following questions, which are a block to my progress:

1. I have a double leather belt, 28 inches wide, transmitting power from a fly-wheel 27½ feet in diameter, making 62 revolutions per minute. If the small pulley has a contact of 137 degrees, what horse power will the belt transmit?

2. The feed water has a temperature of 56 degrees Fahr., and is changed to steam at 132 pound gauge. If an economizer raises the temperature of the feed water to 223 degrees, what is the per cent. gain?

3. What should be the diameter of a white pine beam, 14 feet long, to sustain a load of 26,759 pounds? The beam is horizontal, supported at both ends with the load in the middle.

Warrensburg, Mo. E. A. S.

1. Without going into the mathematics of the subject, the power which may be transmitted by a belt is determined by the difference between the tensions of the driving and following sides and the speed of the belt, the logarithm of the ratio of these tensions being proportional to the coefficient of friction and to the arc of the pulley embraced by the belt. Since, however, the formulæ for belt design are very variable, owing to many varying quantities that are involved, perhaps the best rough rule would be to calculate the horse power transmitted, if the belt had an arc of contact of 180 degrees and take 137-180ths of that amount. For instance, in the given problem, the double belt would transmit 272 horse power if the belt had an arc of contact of 180 degrees, so that with a 137 degree contact, the belt should transmit 207 horse power.

2. In raising one pound of feed water from a temperature of 56 degrees to steam at 132 pounds gauge pressure, 1176 heat units are required, but when the temperature of the feed is 223 degrees, only 999 heat units are required. This means a saving of 177 heat units or 15 per cent. of the heat required to raise the feed water from 56 degrees to steam at 132 pounds gauge.

3. Considering 12,000 pounds to be the maximum strength of the fibres of white pine wood and allowing a factor of safety of 6, the formula for a circular beam fixed at both ends and load in the middle becomes

$$P = 780 \frac{d^3}{l}$$

in which P is the load in pounds, d, the diameter of the beam in inches and l the length of span in inches, from which the diameter can be calculated. In the given case the diameter of the beam should be 17.4 inches.—[Ed.]

Testing Oils.

EDITOR THE PRACTICAL ENGINEER:

Will you kindly publish an easy way to test the cylinder and engine oil with some acid, so as to provve which is the better oil? The only way an engineer has is to try it and then argue on his opinion. Also how do you make a fire test on oils to see which is the best?

Bethlehem, Pa. G. O. B.

The question of oils is a most peculiar one and any chemical test which might be made does not conclusively prove that the oil is best for certain conditions. There are so many conditions involved when running an oil on a bearing or in a cylinder, that chemical tests only indicate what might be expected in practice, although sometimes the results are just the reverse of what might be expected. Perhaps the best way to find out if an oil is best under given conditions is to use it on an oil-testing machine, by means of which the oil can be tested under different conditions and different temperatures and the coefficient of friction obtained for these different conditions. Of

course, the oil should be tested for its viscosity and flashing point, and only oils of certain flashing points and viscosity should be used for certain journals; but very often two oils will be the same viscosity and flashing point, and still act vastly different when used on the same journal. In making a flashing point test the oil is heated very slowly and the receptacle which contains the oil should have a loose glass lid with a small opening. As the temperature rises, it should be tested continually to see if there is any vapor given off. This is indicated by a flash across the surface of the oil, and the lowest temperature at which the oil flashes is called the flashing point.—[Ed.]

Pumps in Series. Hydraulic Ram.

Editor The Practical Engineer:

I would like you to answer for me the following questions:

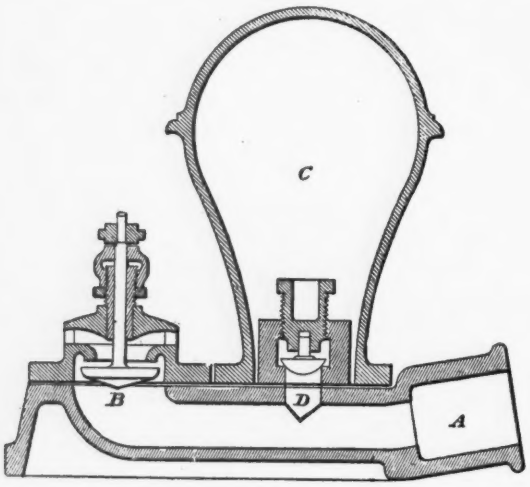
1. Two pumps, double acting and same size, are placed on same level, the discharge of one going into suction of the other. Either of the pumps can pump to a pressure of 100 pounds with suction water flowing through pumps. Can a greater pressure be obtained by this combination than with one pump alone?

2. Describe the principle upon which a hydraulic ram works and give illustration.

Wellsville, O. D. W. P.

1. Yes.

2. A hydraulic ram is a device for raising water for delivery above the level of the source of supply. They are built in several different forms, one of which is shown in the accompanying sketch. A is the supply pipe, B is the pulse valve, C is the air chamber and D is the delivery valve leading to the delivery pipe. Its action is as follows: Suppose the water in the ram to be at rest. When it is in this condition, the pulse valve B is open and the delivery valve D is closed. The water



Hydraulic Ram.—Section through Centre

that passes through the delivery pipe, A, begins to flow with a velocity due to the height of the fall of water from the source of supply, through the pulse valve, B, which is open. The pressure of the moving water acts on the bottom of the valve and closes it. At the moment the water ceases to flow, the resultant momentum of the column of water in the delivery pipe causes the ramming stroke which opens the delivery valve, D, forcing the water to the required height. At the same time, the water enters the air chamber, C. The air is first compressed, then brings the column of water to a state of rest and in virtue of its elasticity, causes the water to flow back through A. The moment the backward motion begins, the delivery valve, D, closes and the pulse valve, B, opens again, allowing the water to flow in a forward direction and the operation is repeated.

The efficiency of this machine is about 65 per cent.; that is, one-seventh of the amount of water supplied can be raised a distance of about 5 times as high as the supply head of the ram; or, one-fourteenth of the water supply can be raised and discharged about ten times as high.—[Ed.]

Action of Soda on Feed Water. Equivalent Evaporation. Thermal Units per Horse Power Hour.

Editor The Practical Engineer:

1. Explain the action of soda on feed water impurities.

2. What should be the diameter of the safety valve of a boiler with 10 square feet of grate area burning 100 pounds of coal per hour yielding 12,000 British thermal units per pound, water entering boiler at 100 degrees F., efficiency of boiler 70 per cent.?

3. Why is it necessary to reduce the actual evaporation to an equivalent evaporation before comparison can be made?

4. Show that the unit of horse power is equivalent to 33,327 British thermal units per hour.

Linwood, Neb. W. F. J.

1. Soda, or carbonate of soda, is found to act well in preventing and removing incrustations consisting of both sulphate of lime and carbonate of lime. The action of the carbonate of soda on the sulphate of lime is to form sulphate of soda, which is very soluble, and carbonate of lime, which, when an excess of carbonic acid is not present, is precipitated without forming a hard incrustation. The reaction of the soda on the bi-carbonate of lime contained in the feed water leads also to the precipitation of the lime salts, because the carbonic acid in excess is taken up by the soda salt and the carbonate of lime is rapidly precipitated. This carbonic acid which is taken up by the soda salt is then liberated by the heat, and the soda is in its original state ready to act again as before. The precipitate of carbonate of lime settles to the quietest parts of the boiler, and can be easily washed out.

2. The opening of the safety valve should have a minimum diameter of 5.5 inches.

3. It is necessary to reduce the actual cost of evaporation of any boiler to an equivalent evaporation, because boilers are operated under very varying conditions, and, consequently, no accurate measurement of the horse power can be obtained unless this data is brought to a common basis. For instance, a feed boiler whose feed water is 60 degrees and whose steam pressure is 100 pounds, will require a large number of heat units than a boiler whose feed water is 180 degrees and whose steam pressure is 60 pounds; that is, it will take more coal to raise one pound of feed water in the former case than in the latter.

4. The number of heat units in a horse power hour is 2,545, which is obtained by multiplying 33,000 by 60 and dividing by 778.—[Ed.]

Number of Incandescent Lamps per Horse Power.

EDITOR THE PRACTICAL ENGINEER:

Please tell me how many incandescent lamps an engine of 150 horse power will maintain when driving an ordinary dynamo.

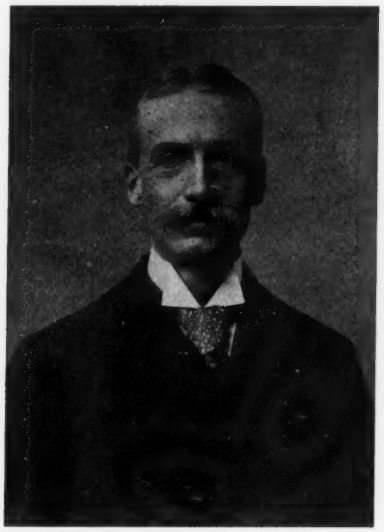
Perth Amboy, N. J. G. F. W.

The ordinary incandescent lamp requires about 3.5 watts per candle power, so that a 16-candle power lamp will require 56 watts. Since there are 746 watts in one horse power, one horse power will supply 13 lamps of 16 candle power, so that 150 horse power will supply about 1,950 lamps of 16 candle power each or twice that number of 8 candle power. As the efficiency of the lamp increases, the greater will be the number of lamps that can be supplied per horse power.—[ED.]

Death of Carleton W. Nason.

The death of Carleton W. Nason, president of the Nason Manufacturing Company, which occurred recently, will bring feelings of deep regret to all who knew him. For more than thirty years he has been closely associated with engineering, and during his life he devoted most of his energy to the management of a business which included the manufacture of many engineering specialties.

He was born in Woburn, Mass., in 1849, and after a thorough education he went into business and succeeded his father as vice-president of the Nason Manufacturing Company in 1872. On the death of Mr. Henry R. Worthington, in 1884, he was elected president of the Company, which position he held until his death.



The Late Carleton W. Nason

Mr. Nason invented the pneumatic lift which is now in such general use in all industrial establishments. He is also credited with introducing a diaphragm or partition in the tubes of radiators and of drop tube boilers to facilitate circulation. He took an important part in the work that occupied the entire steam engineering trade of the country at one time and which is spoken of as the standardization of flanges, the outcome of which was the standard flange schedule which has been in general use for a number of years. The last few years, while continuing to manufacture largely, the Company has assumed a position of prominence in the sale of both steam and plumbing supplies.

In all fields of endeavor Mr. Nason was accorded a high esteem for his strict integrity and for his constant aim to inject into business life high aims and purposes. That he was a genial companion is reflected in his connection with a number of engineering societies and social clubs. He was a member of the American Society of Mechanical Engineers, the Society of Mechanics and Tradesmen, the Atlantic and New York Yacht Clubs, the St. Andrews and a number of other golf and country clubs.

Metal Hose.

With the advent of high-steam pressures there has come a demand for some kind of flexible metal hose which will safely carry these pressures and at the same time remain impervious to the heat and other destructive influences. Rubber hose has been used for these various purposes, but as it possesses various disadvantages, the use of some more durable and flexible conveyance for carrying steam has become imperative.

Flexible Metallic Hose

The flexible metal hose shown in the accompanying illustration is an important invention which furnishes for various purposes a practically indestructible substitute for rubber hose, capable of carrying steam at all pressures and widely used for oils, gas, compressed air and hydraulic purposes. The tubing is said to be positively unaffected by heat or cold, and will remain flexible at all temperatures. It cannot kink or crush, and therefore is always capable of delivering its full capacity under various conditions of service.

The flexible hose is now made in all sizes up to 10 inches in diameter, in either steel or copper, and is used for a multiplicity of purposes. It is used on railroads for water-feed pipes from engine to tender, for heating cars, for conveying steam from station boilers, driving portable drills, for supply of compressed oil gas to cars, etc. In countries where the climate for-

bids the use of rubber hose, this form of tubing is used almost exclusively.

When petroleum, oils or greasy liquids, which speedily attack rubber, are used, this tubing has been found to give good results, the flexibility being further improved by the lubricating action of the liquids passing through it. The fact that it is not inflammable has caused it to be used extensively by gas companies, and its strength from outside influences has caused it to be used by contractors and builders for temporary purposes.

When blowing boilers it is necessary to have a form of flexible hose which will not char and which will not be disintegrated by the heat. The flexible metallic hose is made in specially fitted lengths for this purpose, in either one-half or three-quarter inches in diameter.

For further information address the Pennsylvania Flexible Metallic Tubing Co., 1305 Arch Street, Philadelphia, who will send an interesting catalogue upon request.

Monarch Metallic Ring Packing.

The particular features of the Monarch Metallic Ring Packing are its flexible and self-lubricating qualities. As shown in Fig. 1, the metallic rings are provided with grooves filled with fibrous material for conducting the lubricant to the rod. The

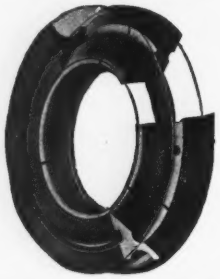


Fig. 1.—Construction of Monarch Metallic Rings

metallic rings are triangular in section and are placed upon each other to form a rectangle, the exterior and interior grooves being filled with asbestos wick. The grooves formed between each pair of rings allow the oil not only to travel back and forth along the rod, but around the piston rod. The lateral passages conduct the oil to the wicking and hence to the rod.

The assembled rings are shown in place in a stuffing-box in Fig. 2. A sufficient number of sections are used to fill the stuffing box, asbestos washers being used at the ends for backing. No amount of wear or tightening can prevent the flow

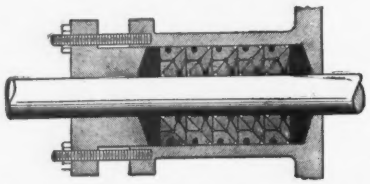


Fig. 2.—Section of Monarch Packing

of oil, so that it can be lubricated constantly and without variation. This packing is designed to be used for packing piston rods for pumps, air compressors and engines, but it is especially recommended for ammonia compressors, where it is desirable to avoid hot compressor rods, smell of ammonia and loss of oil.

This packing is manufactured by the Unique Engineering Co., 5-7 Beekman Street, New York, who will send a set on thirty days' trial to any responsible party sending in the diameter of the stuffing box, diameter of the rod and the depth of the stuffing box.

Eleventh Anniversary of Quaker City Association.

The Eleventh Anniversary of Quaker City Association, No. 1, N. A. S. E., was celebrated at Park Hall, Philadelphia, on November 15th. About 100 members and their friends were present, and the evening was spent in a very enjoyable manner. Refreshments were served early so that there was plenty of time for the "speech-fest" which came after. Among the speakers were James Gillespie, Chief of Elevator Inspection; R. W. Larkins, J. C. McHugh, of Jenkins Bros.; Enoch Careless, Richard Pape, Frank Mellor and William Heinle. V. L. Rupp presided, and kept everything moving along at a lively rate. A number of engineers from other Associations were present, and each brought his felicitation and praised Quaker City on its remarkable growth during the past few years.

Germantown Council Celebrates.

An open meeting of Germantown Council, A. O. S. E., was held on Wednesday evening, November 7th. During the banquet, which was elaborately served, W. H. Toplay spoke on Indicators, A. T. Wyker spoke on Pumps, giving a history of the development of the pump from its origin; other speakers being T. D. Just and L. L. Rice. Mr. H. G. Schlehner acted as chairman.

Newark Engineers Welcome President Kelsey.

The members of Newark, N. J., No. 3, N.A.S.E., tendered a reception to Nat'l Pres., T. N. Kelsey, and Nat'l Vice-Pres., J. F. Carney, on Saturday evening, November 10th, at their meeting rooms on Market Street. The distinguished visitors received an enthusiastic welcome, and members of sister associations helped to make the affair a great success.

The principal speakers were: The Nat'l Pres., Nat'l Vice-Pres., State Deputy, C. T. Runyon; State Pres., W. J. Reynolds; W. H. Cronley, of Jersey City, No. 1; A. C. Lippencott, of Indicator fame; members of the Nat'l Supplymen's Association, and many others. Fraternalism, Education, Co-operation, License Law, The Relation Between the Engineer and the Supplyman, and the Engineering Press were the main topics discussed.

There was an abundance of fuel and water and smoke to keep the boys warmed up, and every one present enjoyed a good time.

It is a fact worthy of note that the total increase in the production of coal in the United States in 1905 over 1904 was larger than the production of France in 1904, or of any other foreign country except Great Britain, Germany and Austria Hungary, and was almost equal to the production of Austria Hungary. The total production of this country last year was nearly 50 per cent. larger than that of Great Britain, which until 1899 was the leading coal-producing country of the world, and was more than double that of Germany. Another interesting fact presented in the statistics of the production of coal in the United States is that in each decade the output has been practically doubled.

TRADE NOTES

EDITED BY THE ADVERTISING MANAGER

The Revere Rubber Co., of Boston, Mass., manufacturers of the Highest Grades of Belt, Hose, Packing, Blankets, Valves, Springs and Rubber Goods for mechanical use, have issued a catalogue which is a "beauty." It is printed in colors and the different products are well illustrated. Among the well known specialties manufactured by the Revere Rubber Co., may be mentioned the Usudurian Sheet Packing, which is particularly adapted to packing steam chest covers and superheated steam joints, Black Hawk Sheet Packing which is adapted to all joints around a power plant, Giant Red Crescent Sheet Packing for high pressure work, Black Cross Packing for rough surfaces and Black Hawk High Pressure Piston Packing, Globe and Angle Valve Packing, and Tubing for Gaskets. These are only a few of the specialties described in their catalogue which will be sent free to any one mentioning THE PRACTICAL ENGINEER.

Feed-water regulation is becoming so essential in all plants where economy is a factor, that there is no branch of the engineering industry which has made such rapid strides during the past few years. By keeping the water level in a boiler at its most economical steaming point means the saving in the cost of fuel, the increased dryness of the steam generated and increased boiler capacity.

The Burrows Feed-Water Regulator and Low Water Alarm guarantees a steady water level and never fails to work. It received the John Scott Legacy Premium and Medal from the Franklin Institute, a rare honor which was only granted after the committee had made a most careful investigation of the merit of the apparatus.

A catalogue and free trial offer will be sent to any one interested. Address the Burrows Manufacturing Co., 73 Warren St., New York City.

Five thousand sets of Grates in use in New England alone, is the record which has been made by the New England Roller Grate Co., Whitney Building, Springfield, Mass. Besides the New England States, these Grates are used in New York, New Jersey, Pennsylvania, Missouri, Ohio, Minnesota and Georgia. A list of a few of the patrons of the New England Roller Grate Co. has just been published. A copy of which will be sent to any one interested in the remarkable growth of this economical grate.

Pittsburg Gauge & Supply Co., Pittsburg, Penna, have advised us that Mr. M. R. Porter has been appointed Sales Manager of their company. Mr. Porter has for many years occupied a similar position, having been an officer and director of the Ball-Knapp Hardware & Manufacturing Co., Louisville, Ky. In his new position, Mr. Porter will be pleased to welcome his old friends and receive any suggestions that will result in the better service between his company and its patrons.

Wilkinson Manufacturing Co., of Bridgeport, Pa., have shipped a lot of Stokers to Taylor Brothers & Co., Leeds, Eng., which were installed by Julian Kennedy. Sahlen & Co., Consulting Engineers, report these Stokers as giving excellent satisfaction. Another recent shipment of Wilkinson Stokers was sent to the Tajaner Eisen Werke, Actien Gesellschafts, Buda-Pest, Austria.

Chas. Jacobs & Co., 51 Oliver St., Boston, Mass., have just issued a small catalogue of the Jacobs Patent Water Tube Feed Water Heater and the Lowden Grease, Oil and Grit Extractor and Automatic Seperator. The meritorious features of these pieces of apparatus are clearly explained in the catalogue which will be sent to any engineer desiring one.

The American Boiler Economy Co. have removed to larger quarters in the Mutual Life Building, Philadelphia. They were formally located at 420 Mutual Life Building, but owing to the rapid increase of the sales of the Copes Feed Water Regulator they have enlarged their facilities. Only words of praise have been heard from users of this apparatus, and it is being used by some of the largest corporations in this country. In one case it was investigated by the heads of five different departments who thoroughly investigated its merits and unanimously recommended its use to their company.

For further information about the Copes Feed Water Regulator and Pump Governor, address the American Boiler Economy at their new quarters, 741-742 Mutual Life Building, Philadelphia.

The Murray Iron Works, of Burlington, Iowa, whose advertisement appears on the front cover of this issue, have had wonderful success with their new Water Tube Boiler, and they are now prepared to equip complete power plants with their Boilers, Engines and other engine room accessories. Their catalogue describing these pieces of apparatus should be had by every engineer.

Mr. J. H. Pearson, 130 Center St., New York City, has secured the general sales agency for the United States for Vellumoid Sheet Packing. This remarkable product which looks like paper, is said to be exceedingly good for both hot and cold oils, acids, ammonia and for almost any service where other packings disintegrate quickly. Write for a sample of it to the above address.

The Philadelphia Lubricator & Manufacturing Co. will be located after December 1st at the Exhibition Department of the Bourse, Philadelphia. They were compelled to change their quarters from the Land Title Building on account of the rapid growth of their business, due to the increasing popularity of the Philadelphia Grease Cups and Cylinder Lubricators. In their new quarters they will have a daily and constant demonstration of a system of lubrication, which, for simplicity, cleanliness, economy, reliability and efficiency, deserves attention.

It is not often that such a good chance is available of securing a high-grade sight-feed lubricator at a very low cost as is offered by William Arkley, 319 North St., Steubenville, Ohio. Mr. Arkley has purchased all the lubricators of the King Lubricator and Brass Supply Co. and is able to offer them at a very low price. Each lubricator is fully guaranteed and will feed any kind of oil. The price and descriptive cut of the lubricator will be found on page 68.

ENGINEERS—Send your address and we will send you a set of Corliss Valve Rod Packing free of charge. Give diameter of Rod, Gland, and depth of box. Ideal Metallic Packing has no equal. We have the documents to prove it. IDEAL METALLIC PACKING Co., Box 52, St. Paul, Minn.

One setting only is required on the
RUNNERLESS SLIDE RULE

to solve any of the following three proportions: $a:b=c:d$, $a:b=c^2:d$, $a^2:b=c^2:d$. New Method of Operating explained in Booklet. F. F. Nickel, 27 Winans St., East Orange, N. J.

"POLARITY INDICATOR, 25 Cents Works on any voltage; satisfaction guaranteed. Postpaid to any address on receipt of price (coin). J. H. Gravell, 1005 Drexel Bldg., Phila., Pa."

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WANTED—Engineers, Firemen, Electricians and all steam users. Do you want to be "put wise"? Send for 52 page pamphlet containing Questions asked by the different Examining Boards throughout the country. Sent FREE. GEO. A. ZELLER BOOK CO., 62 So. 4th St., St. Louis, Mo.

Wanted Salesmen traveling among engineers to sell the France Metallic and Fibrous Packings. Good inducements on unoccupied territory, Address
FRANCE PACKING Co., Tacony, Phila., Pa.

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PATENTS PROMPTLY SECURED. Highest references from prominent manufacturers. Write for Inventors' Handbook, SHEPHERD & PARKER, 186 Deitz Building, Washington, D. C.

The Philadelphia branch of the New York Belting & Packing Co. Ltd., are giving a very unique souvenir to engineers who send in an order for their Ring or Sheet Packing. It is a full concave Razor, made and guaranteed by one of the best makers. If it does not prove satisfactory it can be exchanged. For further particulars address New York Belting & Packing Co. Ltd., W. R. Wood, Packing Dept., 116-120 N. 8th St., Phila., Pa.

Every engineer is interested in the latest and improved methods of getting scale out of boilers; therefore write to the Lagonda Mfg. Co., Springfield, Ohio, for a copy of their book entitled "Boiler Scale and its Removal" before the edition is exhausted. This book is sent free to any one requesting it. It contains valuable information and over thirty illustrations showing how the worst scale may be cheaply removed from any kind of boiler and the method for doing it.

Mr. John H. Foote, New York manager for McLeod & Henry Co., reports that the sales of "Steel Mixture" for the past ten months of the current year have far exceeded the sales for any twelve months in the history of the company.

The Pittsburg Feed Water Heater Co. report the following recent sales: Carnegie Steel Co., "Carrie" Furnaces, 4,000 H. P.; J. G. Johnston Lime Stone Co., New Castle, Pa., 300 H. P.; Wm. B. Moses & Co., Washington, D. C., 200 H. P.; Frank M. Mann, Austen, W. Va., 200 H. P. They are getting out a new and handsome catalogue for 1907 showing their new Open and Closed Type Heater and also the Horiozntal Type Heater. A copy will be sent to anyone mentioning THE PRACTICAL ENGINEER.

The Keystone Lubricating Co., 20th and Allegheny Ave., Philadelphia, have received the following letter from the William Cramp and Sons Ship and Engine Building Co., of Philadelphia, signed by C. R. Spare, Chemists.

Gentlemen:

The sample of Keystone Grease No. 1 Density submitted by you, has been subjected to a chemical examination as per custom with results as follows:

KEYSTONE GREASE NO. 1 DENSITY.

Free Fatty Acids	0.14 per cent.
Free Mineral Acids	Nil
Rosin Oils	Nil
Talc, Graphite, Clay, etc.	Nil

The above sample of grease was found to be entirely free from all deleterious substances, such as would cause decomposition of the grease, or would have any detrimental effect upon metal surfaces.

Every user of lubricating oils knows that the larger portion of the oil he buys, is not consumed by the machinery on which it is applied, but passes through the bearings, drips away and is lost, unless special means have been taken to gather the waste oil in drip pans or buckets placed under the bearing. If this waste oil is gathered and passed through filters, all dirt, grit and other impurities, will be eliminated, and the waste oil can be used over again.

An interesting catalogue which describes how this can be done, has just been issued by the Burt Manufacturing Co., of Akron, Ohio, the manufacturers of the Cross Oil Filter and the American Oil Filtering System. This catalogue is very interesting and should be in every engine room. It also describes Ventilators and Exhaust Heads for power plants.

Mr. Randolph Brandt, of 70 Cortland St., New York City, is in receipt of the following letter under date of November 12th, 1906, signed by Hugh Mooney, Chief Engineer of the James Evardts Brewerers' Ice Plant, New York City:

"Replying to your inquiry as to my experience with the 'Zena' Packings, I have used these packings on Ammonia Compressors, Corliss Valves, Piston Rods, Ammonia Valves, Outside Packing Plunges, Throttle Valves and whenever Gland Packing can be used. In every place the packing has proved as good as any packing I have heretofore used, and in many places better than any. I congratulate you on putting on the market so good a packing."

The Kerr Turbine Co., of Wellsville, N. Y., through their Philadelphia Agency, B. Remmers & Sons, 328 The Bourse, have secured the contract for the new power plant to be installed in the Bennett Building, Fulton and Ann Sts., New York City.

The power plant to consist of Steam Turbine Generators of a combined capacity of 200 Kw. will be made up of two—75 kilowatt Burke Generators, 125 volt direct current each, direct connected to a 24-inch 6-stage Kerr Turbine, and one 50 kilowatt 125 volt direct current Burke Generator, direct connected to an 18-inch 6-stage Kerr Turbine.

The Kerr Turbine Co. maintain a permanent exhibit in operation in the Exhibition Department of the Philadelphia Bourse.

The Joseph Dixon Crucible Co., Jersey City, N. J., publish a very interesting pamphlet on the subject of steam traps. It is an illustrated description of the several varieties, with valuable suggestions by W. H. Wakeman, expert steam engineer and author of well-known books on steam engineering.

Some steam users seem to think that a steam trap is only a luxury to be enjoyed by those who have expensive plants in operation and wish to show many extra appliances which might be dispensed with, and not be missed. This is a great mistake, as a trap is valuable according to the cost of fuel that must be burned to make the steam. Certain it is that this pamphlet is well worth most careful reading, for it is instructive as well as interesting.

A unique and handsome Flexible Metallic Pencil can be obtained absolutely free, by writing to the Pennsylvania Flexible Metallic Tubing Co. See their advertisement in this issue.

GRAPHO
SOMETHING NEW
A new preparation for enriching oils.
Will suspend in oil.
No more Hot Journals.
Engineers who have tried same claim it to be the best yet.
SEND FOR SAMPLE
A trial will convince you
AGENTS WANTED
GRAPHO MFG. CO.
Cor. Frank and Commercial Sts.
ROCHESTER, N. Y.

EVERY LIVE ENGINEER SHOULD HAVE THESE
BOOKS

THE CORLISS ENGINE, by John T. Henthorn, and "The Management of the Corliss Engine," by C. D. Thurber. This is a practical hand-book for Engineers and their Assistants. 52 illustrations, attractively bound in cloth. Price, $1.00.

A, B, C OF THE STEAM ENGINE, by J. P. Lisk, M. E. Just the book to give practical help to Firemen Helpers and Young Engineers. Price, 50 cents.

AMMONIA REFRIGERATION, by I. I. Redwood. Every engineer employed in the management of Ice and Refrigeration Machinery should have the information in this standard work. 150 pages, 15 illustrations and 24 pages of tables. 12mo. Cloth. Price, $1.00.

DIAGRAM OF THE CORLISS ENGINE. Makes it easy to know more about the Corliss Engine. Longitudinal Section of Engine Cylinder, showing Relative Positions of the Piston, Steam Valves, Exhaust and Wrist Plates when cut-off takes place at ¼-stroke for each 15 degrees of the circle. Size, 13 inches by 19 inches. Price, 25 cents.

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123 P. E. Liberty St., New York

The Smith Pipe Clamp

Stops The Leak Every Time

A complete set for every size of pipe in your plant will save many a dollar. Quickly applied while pressure is on the pipe WE GUARANTEE TO STOP THE LEAK. Steel or brass, all sizes, ¾-inch to 20-inch. No trouble to send further information.

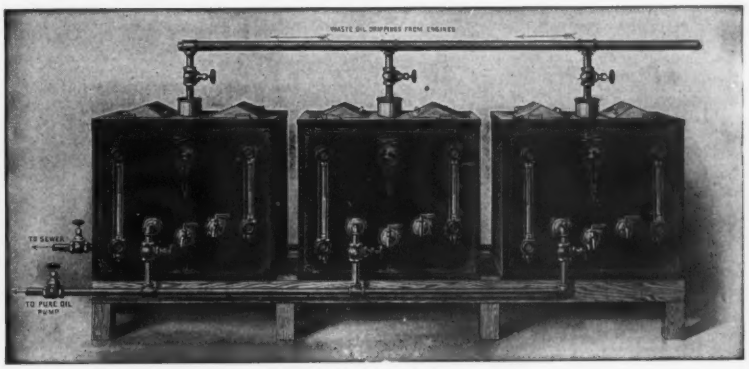
W. CLIFFORD SMITH
138 N. SIXTH STREET
PHILA., PA., U. S. A.

A Recommendation of Unit Oil Filters Beyond Dispute.

It is one thing to **write** a recommendation, but the best proof of excellence is when the customer **keeps buying** more.

After a series of most exacting tests, the Philadelphia Rapid Transit Co., which operates eight of the most modern power plants in the U. S., selected six "Units" over all the leading makes of filters on the market—a short while after they added four and recently they installed six—making a total of sixteen "Units" in all. Just as this advertisement goes to press we have received an order for 4 more, making 20 now installed. That's proof isn't it?

You can't get around a recommendation of that caliber.

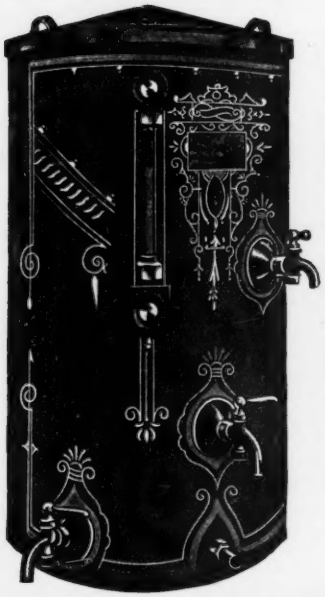


THREE "UNITS" CONNECTED AND OPERATED AS ONE FILTER

Unit Filters can be operated with or without an oiling system and can be operated singly or with a number, so as the plant increases additional "Units" may be added.

In our new 64-page catalog just issued—the most handsome catalog ever put out by any oil filter concern—you'll find all the particulars. If you are connected with power-plants or a manufacturing concern, you should certainly get a copy. It also contains a description of our Cross "American" and Warden Oil Filter, The Burt and Standard Exhaust Heads and the Burt Ventilators.

YOU NEED A CROSS OIL FILTER



to remove that dirt, grit and water from the lubricating oil.

Requiring very little attention after starting and operating without expense — except a few cents a year for waste—it is possible to use the oil over and over again, because the Cross first strains the oil through waste then washes it in pure warm water.

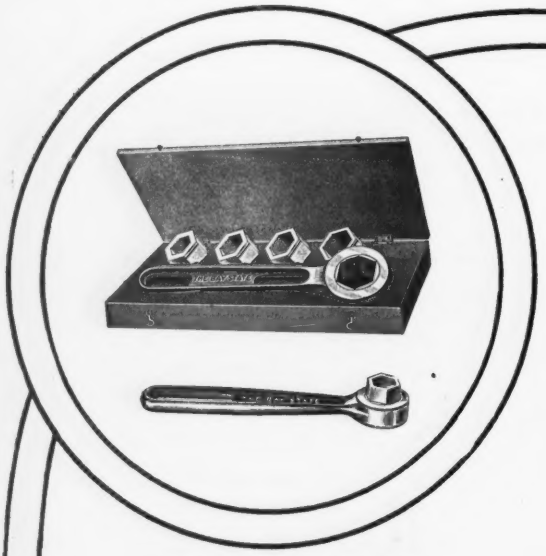
Cannot clog and has nothing to get out of order.

THE BURT EXHAUST HEAD SAVES MONEY

because it prevents expensive repairs by preventing rotting roofs, disfigurement of buildings. It prevents icy sidewalks and positively removes water and oil from exhaust steam lines. Is noiseless and is the strongest, most safe and most reliable head made.

The Burt Mfg. Co. Largest Manufacturers of Oil Filters in the World. 204 Main Street, AKRON, OHIO, U. S. A.

Also supplied by Engine Builders, Dealers and Power Contractors



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Write for descriptive circular of our many quick acting tools.

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"BAY STATE TOOLS"

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SAVE YOUR BELTS

BY USING

Wolff Dressing

IT CLEANS THE BELT. Prevents friction
Does not Gum up Belt or Pulleys.
Preserves the Leather—or Rubber.
Specially adapted to Loose Belts.
ALWAYS READY. NO Heating.
Goes further than any other. No waste.
The SAVING in Power and Preservation of the Belts exceeds its cost many times over.
It has been ADOPTED for this reason by the largest concerns in the country.

SATISFACTION GUARANTEED

In ordering specify whether for Leather or Rubber Belts

THE NORBERT WOLFF CO.

472 Greenwich Street New York, U. S. A.

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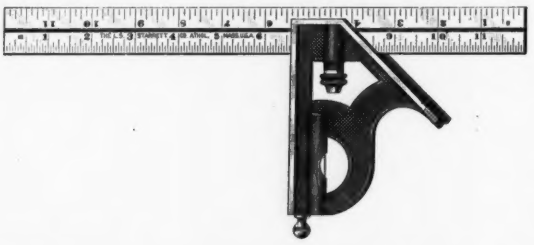

And all you have to do to get a six inch Starrett Combination Square just like the cut shown above is to send us **four** subscriptions to The Practical Engineer at fifty cents each. This is one of the most convenient and useful tools ever devised for mechanics use. It is a complete substitute for a whole set of try squares and can be put to a hundred different uses.

THE PRACTICAL ENGINEER

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FOR SEVERE SERVICE

BLACK HAWK SHEET PACKING IS A HIGH GRADE RED SHEET, COATED ON BOTH SIDES WITH PLUMBAGO, WHICH PERMITS YOUR JOINTS BEING BROKEN REPEATEDLY

CUT OR MOULDED GASKETS FURNISHED ON SHORT NOTICE

WILL NOT HARDEN UNDER STEAM HEAT AND IS NOT AFFECTED BY AMMONIA.

A TRIAL WILL CONVINCE YOU.

FURNISHED WITH IRON OR BRASS WIRE INSERTION WHEN DESIRED

Try BLACK HAWK TUBULAR GASKETS

FOR LONG LIFE THEY HAVE NO EQUAL

FULL ILLUSTRATED PACKING CATALOGUE SENT FREE

WRITE FOR OUR LARGE CALENDER FOR 1907

REVERE RUBBER CO.

FACTORIES
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HOME OFFICE
BOSTON, MASS.

BRANCHES:

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PHILADELPHIA	MINNEAPOLIS
PITTSBURG	NEW ORLEANS
SAN FRANCISCO	PORTLAND, ORE.

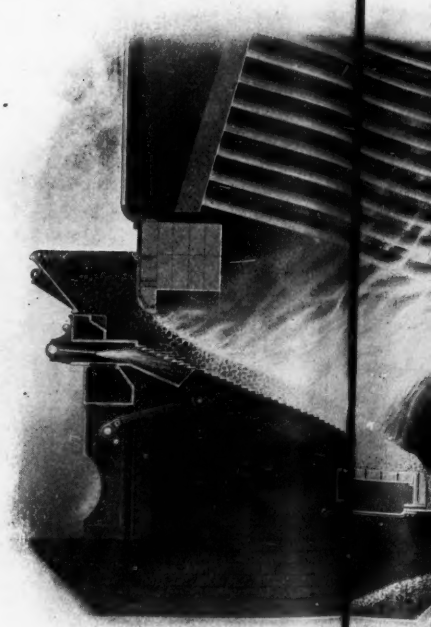
WILKI
STOK

Watch this Stoker. See it in action. See how intelligently and with what infinite care and economy it feeds coal. It almost seems to know that coal costs money.

That Wllkinson motion—wonderfully simple and accurate—advances the coal across the inclined grate as evenly as shot across an inclined plate. No coal escapes! Each lump is entirely consumed and ejected as ash.

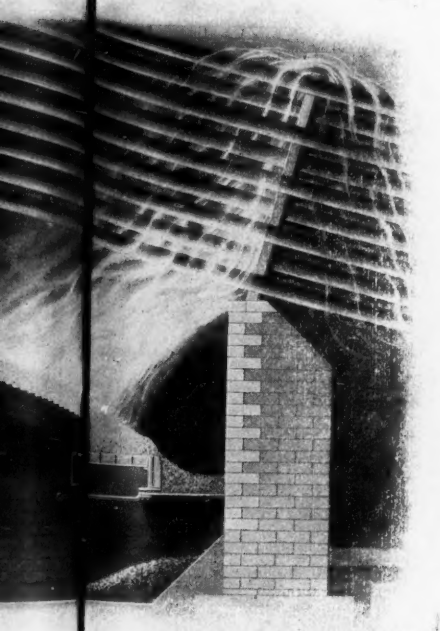
There is no smoke!

Smoke represents unburned coal—lost up the chimney!



Wilkinson Mfg.C

INSON
KERS



As the Wilkinson consumes coal to a clean ash, no smoke is possible.

Many large concerns—they that owe their successful growth to the use of modern labor saving and money saving devices—use the Wilkinson Stoker—and the list is growing every day. If you believe in fuel economy and realize the nuisance of smoke—and we believe you do—send us the number and size of your boilers; also the kind of fuel you use and we will mail you interesting facts about the Wilkinson that you will be glad to know.

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Montgomery Co., Pa.

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IT SHOULD BE IMPORTANT TO ENGINEERS AND STEAM USERS

to know that the formulas of

WARLEY'S BOILER CLEANSING COMPOUNDS

are founded on sound chemical principles, and that only the purest grades of chemicals obtainable, regardless of cost, are used in the preparation of these goods, which have now been on the market throughout the United States and Canada, and in many other foreign countries as well, for a great many years, and they are now well and favorably known to thousands of Engineers and Steam Users as Boiler Cleansing Compounds that positively remove incrustation or scale and prevent corrosion and pitting in steam boilers, without doing any injury to the boilers, or their fittings, or to any goods in course of manufacture while using the live steam from the boilers with these Compounds in use therein.

These Compounds are varied to suit the individual needs of steam users, and the grade required can be determined when we are furnished with a small piece of scale from the boiler in which the Compound is to be used, a piece weighing about two ounces will be large enough for our purpose.

Send for Blue Book "Questions and Answers for Engineers, etc.," which we will mail to any Engineer, free, who is in charge of a steam boiler, and who will give us the name and address of firm by whom employed and send us a small piece of scale from his boiler, also mention this paper. Address :—

No. 221 South Front Street **THOS. C. WARLEY & CO.** **PHILADELPHIA, PA.**

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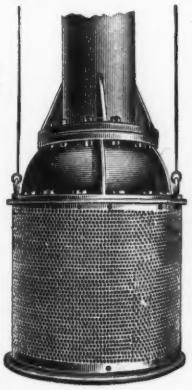
The Continuous Service

Foot Valve

Water can be taken continuously and without interruption from streams and ponds that are full of leaves, twigs, fish, sticks, paper and other refuse.



Outer Screen resting on bottom plate

NO STOPPAGE FOR CLEANING

The outer screen is raised by ropes or chains for cleaning.

Outer Screen Drawn part way up on suction pipe

When outer screen is lowered into position the knives at top and bottom scrape the outer surface of the inner screen and clean it.

The suction pipe extends to within a few inches of the bottom plate of valve, thus permitting of successful operation in shallow water.

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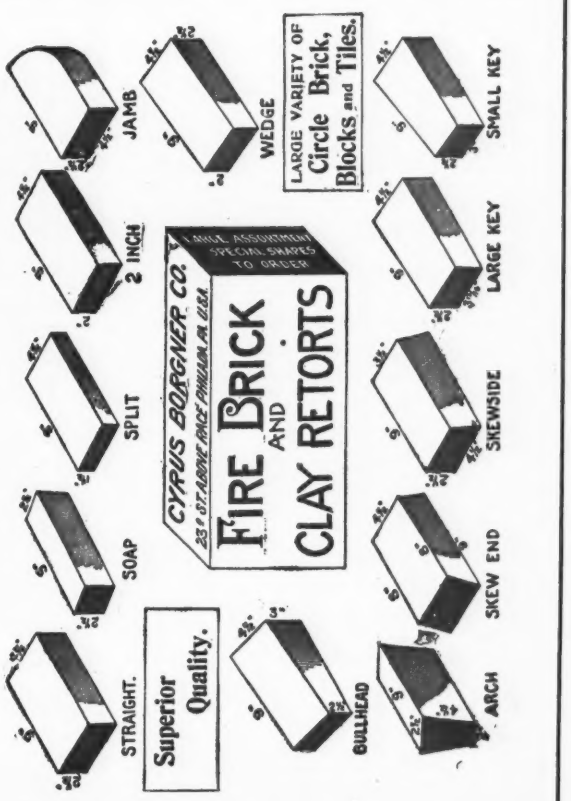


Every Engineer

desires to operate his plant with the utmost practicable economy.

Every Employer

is anxious to keep the expense account just as low as possible.

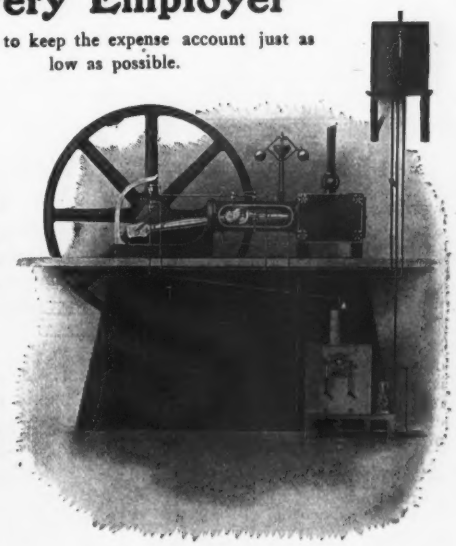
In a power plant where the

White Star Continuous Oiling System

is in use, the saving of oil is astonishing from the start and and becomes fairly astounding as the weekly items pass into the monthly totals, and the monthly totals mount into yearly aggregates showing

REDUCTIONS OF FULLY ONE-HALF

The savings begin with the first minute the system is in operation. We have been collecting facts and figures on the subject which we will be pleased to send, together with booklet "F" which illustrates and describes our method of perfect and economical lubrication of engine bearings. Send for it.



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Lightens YOUR Work

It permits cutting down of oil supply, that's one way.

It makes piston packing wear longer, that's another way.

It renders cutting of bearing surfaces absolutely impossible always

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NO COST FOR REPAIRS

In the Robt. Bines Building, Chicago, a 16-inch, 6-ply "Leviathan" has been running for eleven years under the sidewalk, where it is impossibe to keep from water and drippings from the street.

The 22-inch main driving belt in the same building has been running for twelve years. Neither of these belts has cost one cent for repairs since being placed upon the pulleys.

MAIN BELTING COMPANY
Sole Manufacturers
1225-1235 Carpenter St. Phila.
55-57 Market Street, CHICAGO
40 Pearl Street, BUFFALO
120 Pearl Street, BOSTON
309 Broadway, NEW YORK

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RED SEAL BOILER COMPOUND

have been on the market over 13 years. Its sales are constantly increasing. Why? Because its quality and effectiveness are understood by intelligent engineers.

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THE CHERRY CHEMICAL CO.
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OLIVER BRADEN, Manager Write for Circulars

The Best Lubricant
AIR
MICA FLAKE
FLOATED

Use it once and no other lubricant will ever satisfy you Greatest lubricant ever discovered. Try it on the worst bearing you have, or in your cylinder.

SAMPLE FREE
O. & W. A. WORNER
1529 Porter St. Philadelphia, Pa.

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if not properly done, in any plant, will cause the engineer a great deal of trouble, and his employer unnecessary expense. Many years of practical experience and a force of competent assistants enables me to guarantee absolute satisfaction.

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THE GENUINE
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GANDY
PATENTED 1877

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HELPS THE ENGINE DO ITS DUTY

because it grips, not only when the load is steady, but when it's jumping from one extreme to the other

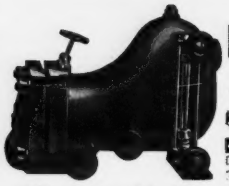
Let us send you our booklet "Experience with Gandy" its worth reading.

GANDY BELTING CO. BALTIMORE, MD.

GANDY 6 PLY

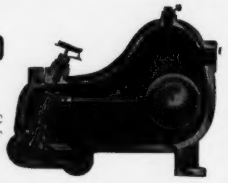
GENUINE GANDY

McDANIEL
Improved Steam Trap



All the working parts are connected to the bonnet and are removable with it, making it most convenient to repair.

You never have to break a pipe joint they are all on the body.



We know this Trap will please you. May we send you one for trial.

Reducing Valves, Exhaust Pipe Heads, Ejectors, Relief Valves, Separators, etc.

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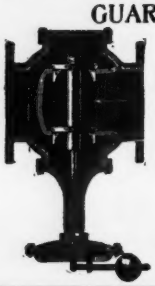

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and more of your total steam is **lost** through leaking joints.

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You may have used the

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packings and at the solicitations of Salesmen tried other brands. Why not try the "Selden" again? It is made either with Rubber core or Canvas Core and will cost less, use less power and cannot scratch or cut a rod. A few rings mixed with any other brand of packing improves the latter. Drop a postal card to the manufacturer.

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to a well ordered plant, and is just as important as fuel regulation. A water line which is fixed, and lived up to, so to speak, means a saving in fuel, in boiler and engine wear and in condensation, because a uniform steam space in the boiler means drier steam.

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Feed-Water Regulator and Low Water Alarm

guarantees you a steady water level. It never fails to work. It was designed especially for batteries of boilers, one machine to each boiler directly controlling the water supply. The device is strongly, accurately and simply constructed, contains no stuffing box, no packing, no springs to get out of order and require repairs and all internal parts are of brass. It is adaptable alike to high or low pressure boiler plants, and can be installed as easily as an ordinary water column.

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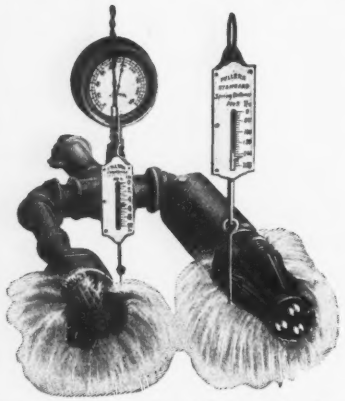

The "DEMON" on the right of photo showing over 40 times the pulling power of the Turbine on the left. Pump pressure 100 lbs.

For years before the invention of the "Demon" the engineer in charge of water tube boilers had to content himself with small inefficient cleaners weak in operation and construction. There was no real and positive force about them. Should the machine be urged forward a little it would provokingly come to a dead stop. The operator must tiresomely pull and jerk the cleaner backward and forward, exhausting patience and strength as well.

The power of a turbine cleaner is small because the wheel is located crosswise of the tube and is therefore smaller than, and limited by the diameter of the tube.

The power of the "Demon" is great because its pistons are located lengthwise of the tube and the area that the water pressure acts on is not limited by the diameter but by the length of the tube.

A LARGE PISTON AREA MEANS POWER.

The result is that the "Demon" is many times the most powerful water tube cleaner ever seen and is even guaranteed to clean perfectly tubes absolutely closed with scale.

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The "Torpedo" scale remover for fire tube boilers has been on the market for 3 years and hundreds are in use both here and abroad.

The "Torpedo" is recognized everywhere as the standard. Why?

Because it is simple and durable—has but one working part.

Because it is the only machine of its nature that vibrates instead of pounding and hammering the tubes. The hammer idea is absolutely a thing of the past.

Try a "Torpedo" and see for yourself. Also send for our new circular No. 30 "How to tell a good fire tube cleaner."

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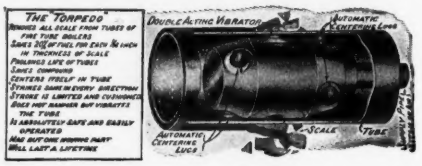
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REMOVES ALL SCALE FROM TUBES OF FIRE TUBE BOILERS
SAVES 20% OF FUEL FOR EACH 1/16 INCH IN THICKNESS OF SCALE
PROLONGS LIFE OF TUBES
SAVES COMPOUND
CENTERS ITSELF IN TUBE
STRIKES SAME IN EVERY DIRECTION
STROKE IS LIMITED AND CUSHIONED
ANGLE HOT HAMMER BUT VIBRATES THE TUBE
IS ABSOLUTELY SAFE AND EASILY OPERATED
HAS BUT ONE WORKING PART
WILL LAST A LIFETIME
DOUBLE ACTING VIBRATOR
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SCALE
TUBE
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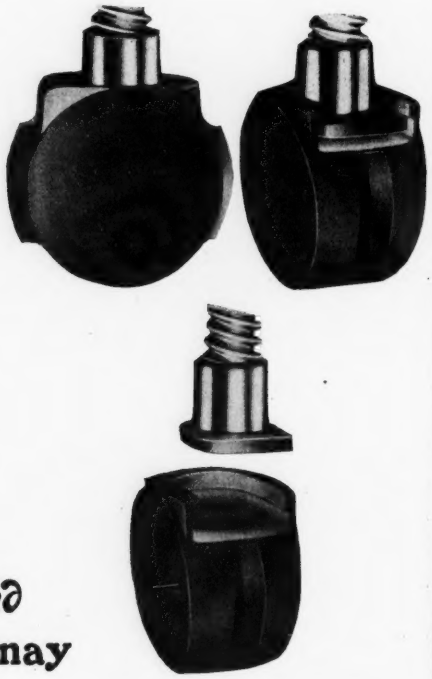

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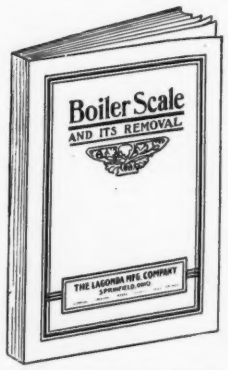

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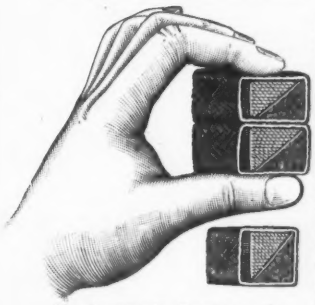

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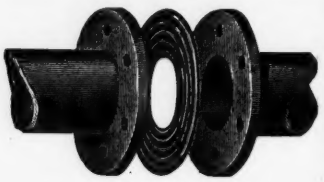

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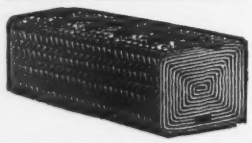

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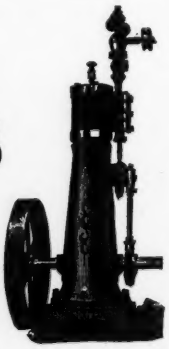

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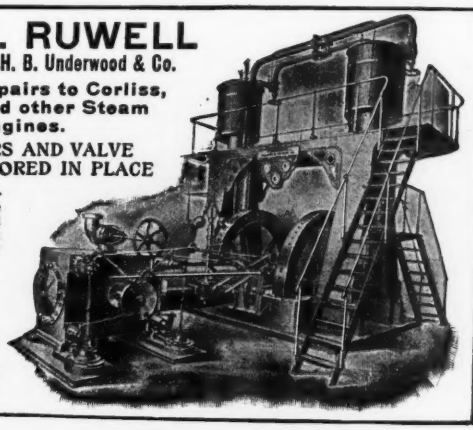

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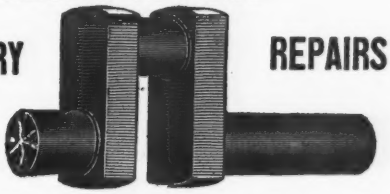

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Made in steel plate for lime water and cast iron construction for acid waters to suit conditions.

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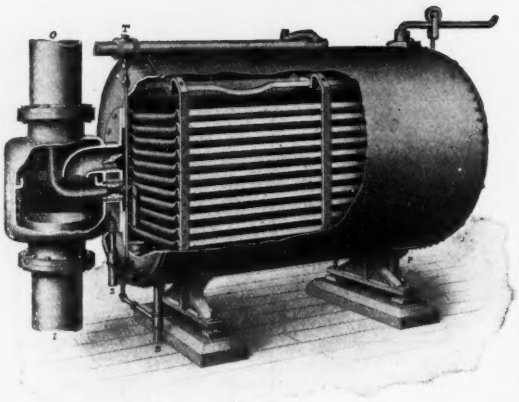

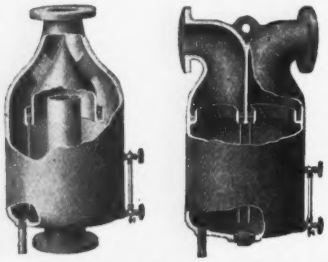

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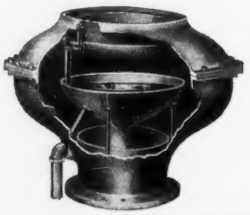

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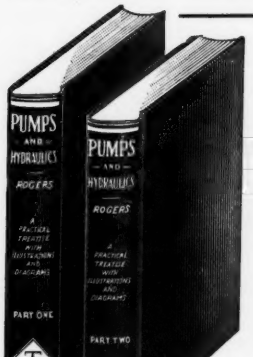

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Old Kellam Regulators Repaired.
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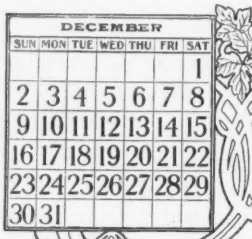
Mention this paper if your inquiry is prompted by the sight of this advertisement. Catalogue D free on application.



MONDAY MORNING
DAMP DAYS
AND OTHER DAYS

STEPHENSON
BAR BELT DRESSING

is a friend indeed to every man held responsible for the proper running of Belts.

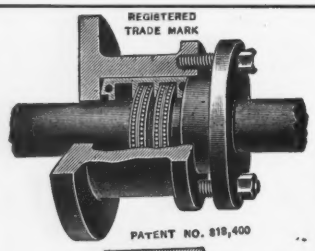
WRITE US FOR FREE SAMPLE - THE TEST WILL CONVINCE YOU QUICKER THAN MUCH TALK

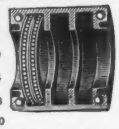
RED LABEL FOR LEATHER GREEN LABEL FOR RUBBER OR CANVAS.

No one kind is good for all belts.

STEPHENSON MFG. CO. ALBANY, N.Y.

REGISTERED TRADE MARK





PAT. NO. 486,177 " " 500,699 " " 534,104 " " 602,828 " " 774,490

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Holmes Packing

is now recognized as being superior to all others and is a common name among engineers

First cost, only cost.
Guaranteed 3 years. No Cutting. No Friction.
Less Oil.
Thirty Days Trial.

Send for Catalogue H.

Holmes Metallic Packing Co. WILKES-BARRE PENNA.

The United States Metallic Packing Co.

PHILADELPHIA AND CHICAGO

WE MAKE A SPECIALTY OF ALL KINDS OF

Hydraulic Repair Works

ENGINE AND STEAM PUMP REPAIRS

Special attention to erection of engines, boilers, pumps, Hot-Air Pumping Engines, etc. Our work the best and charges moderate.

PHILADELPHIA HYDRAULIC WORKS
1218 Cuthbert Street, PHILADELPHIA, PA.

CUT DOWN YOUR PACKING BILLS: HOW?

Use "Ambest" Metallic Packing

Just think of it—**One size of packing for every size rod and stuffing box.** Requires no measurements—needs no replacing—and can be used over and over again.

The Dover Coal Co., of Central City, Ky., could not find a packing that would hold their high duty mine pumps until "Ambest" came to the rescue—result, a happy engineer—no loss of time—and a satisfied customer.

The Royal Spring Ice Co., of Georgetown, Ky., were going to "throw out" their ammonia pumps—were constantly leaking—had spent an enormous amount of money on worthless fabric packings. Were induced to try "Ambest"—result, "tickled to death"; leakage stopped—will pack at once all of their engines and pumps with "Ambest."

Make your engineer's life happier by stopping leakage of steam; cutting down your packings bills in half, your fuel bills lessened, and a general air of contentment pervading your entire establishment. "Nobody works but the Power Plant." Moral, "Ambest" am best. Free sample upon request.

"Ambest" is put up in 1, 2, 5, 10, 25 and 50 pound cans

Write us stating by whom employed, number of engines and total h. p. and we will send you a SAMPLE CAN

Free

Will send name of our agent nearest to you upon request.

CANFIELD MANUFACTURING CO. Ltd.
116 Lehigh Ave., Philadelphia, Pa.

FREE To Any Engineer

A TABOR CROSBY OR AMERICAN-THOMPSON

INDICATOR

Also 500 other things including every article, tool or device an engineer may want. For Free premium list and full particulars regarding this remarkable offer, fill out and mail us the coupon below.

FRANCE PACKING CO., Inc.
State Road, Tacony, Philadelphia
MANUFACTURERS OF
METALLIC, FIBROUS AND SHEET PACKINGS

Tear OFF Here

Date,_____1904.

FRANCE PACKING CO.,
State Rd., Tacony, Philad'a.

Gentlemen:

Kindly send me premium list and full particulars regarding the indicators and other articles you are giving to engineers.

My name is_____

My address is_____

I am employed by_____

Give Complete Address.

The Ashton Quality

POP SAFETY VALVES
RELIEF VALVES
BLOW - OFF VALVES

can be trusted at all times, being of a superior quality and guaranteed to give perfect satisfaction.

Send for catalog "D"

THE ASHTON VALVE CO.
271 Franklin St.
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STEAM AND VACUUM GAGES
RECORDING GAGES

are absolutely accurate and reliable, having non-corrosive movements.

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110 Liberty St., New York
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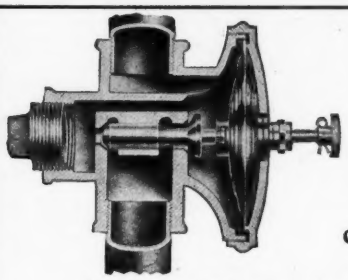


No Wire Drawing

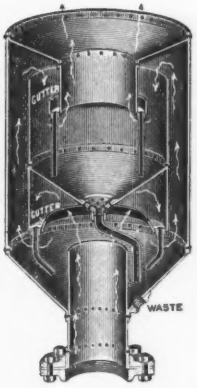
WITH THE

DUNHAM STEAM TRAPS

Our Proof — Thousands of satisfied customers.

Send in your trial order today and be convinced.

C. A. DUNHAM CO.
MARSHALLTOWN, IOWA
Resident Manager, L. BANCROFT MELLOR
No. 14 S. Fourth Street, Philadelphia, Pa.



YOUR ROOF IS ROTTING

YOU CAN PREVENT IT

INSTALL

The Wright "Cyclone" EXHAUST HEADS

PERFECT IN THEORY AND CONSTRUCTION
ABSOLUTELY NO BACK PRESSURE

PREVENTS THE CONSTANT SPRAYING OF OIL, WATER AND IMPURITIES ON YOUR ROOF AND WALLS. MUFFLES ALL SOUND.

Results Guaranteed. Send for Illustrated Catalog.

Wright Manufacturing Co.
DETROIT, MICH. 72 WOODBRIDGE STREET

WHAT DO THE WORDS

Steam Trap Mean?

Does it mean that the steam and condensation should both be traped, or does it mean to discharge both the condensation and the steam? **No! It means to discharge the condensation and trap the steam.** That is just what the **Lindstrom's Corliss Valve Steam Trap does.** It never wastes any steam and is sure to remove all the condensation, no matter how much there is, as it is the greatest Emergency Trap on the market, and further-more it is impossible for any scale or other impurities to get between the Valve and the Seat, which is always tight and reliable.

A trial of 30 days will convince you that Lindstrom's Trap is worthy of its name.

SHEIP & VANDERGRIFT. 814. 836 N. Lawrence Street

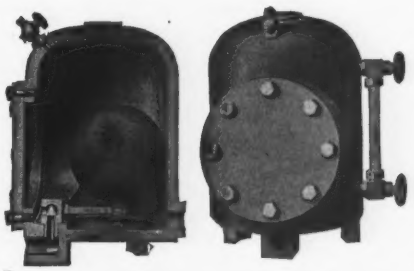
MR. JOHN T. LINDSTROM, M. E. Philadelphia, Pa., Oct. 18, 1906

Dear Sir:—Your letter of inquiry of recent date in regards to the efficiency of your Corliss Valve type of trap installed by us.

Would state that the trap is giving entire satisfaction. I consider it the best trap on the market and will install them whenever a trap is required.

I remain respectfully
FRANK K. DUKE, Chief Engineer

A Catalogue which also includes Corliss Engine Valve setting accompanied by diagrams and tables is sent free.



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John T. Lindstrom
214-216 S. Third Street
ALLENTOWN, PENNA.

PHILADELPHIA AGENTS
American Boiler Economy Co.
420 MUTUAL LIFE BLDG., PHILADELPHIA, PA.

Keystone Grease

Yours for Service

"The World's Greatest Lubricant"

FREE

AN Engineer's Cap, a Large Can of KEYSTONE GREASE and a Heavy Brass Grease Cup.

The value of KEYSTONE GREASE as a machinery lubricant is most apparent under severest tests, for never a first order for KEYSTONE GREASE was booked by us until it had been tried and proven, in fact we never ask an order without a trial and we make no conditions either, we say try it where you will, on engine or auxiliary—on shafting or machinery—and if there is a particular troublesome bearing try it there—it has won its way through merit alone, and by merit it will continue to win.

One pound of KEYSTONE GREASE will lubricate better and last longer than three to four pounds of any other grease or four to six gallons of high grade oil.

To any engineer who will send us his name and business address we will send FREE (express paid) an engineer's cap, a heavy brass grease cup, and a large size sample can of KEYSTONE GREASE all we ask, is for him to tell us the H. P. of engine, R. P. M. of crank pin, on what bearing and width of bearing he will test KEYSTONE GREASE and to give us size of tap that we can send cup to fit. Remember no charge now or afterward.

KEYSTONE LUBRICATING CO.

Address Dept. F, Philadelphia, Pa.

H. L. CARPENTER, N. E. Mgr.
30 Oliver Street, Boston, Mass.

C. A. DENNISTON, Mgr. Western Branch
1102 Tacoma Bldg., Chicago, Ills.

THOMAS & BISHOP,
Finsbury Pavement, London, E. C. General British Agent

R. D. JACKSON, JR., New York Agent,
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DEARBORN LABORATORIES

Have introduced Chemistry in the scientific, correct and economical treatment of boiler waters. Gallon samples of the feed water are analyzed from time to time, and the treatment furnished constantly meets requirements in the prevention of scale, corrosion, foaming or such troubles as each particular water may produce.

DEARBORN TREATMENT will positively keep your boilers clean and well preserved.

DEARBORN TREATMENT is made on such lines that the quantity required to treat each thousand gallons of water is small, consequently its use is economical.

You are further assured that a house of chemical standing will use no materials that in themselves would be injurious to your boiler plant.

If you have not adopted Dearborn Water Treatment as thousands have done, send us gallon of water for analysis and proposition.

DEARBORN DRUG AND CHEMICAL WORKS

WM. H. EDGAR, Founder

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DENVER, Boston Block
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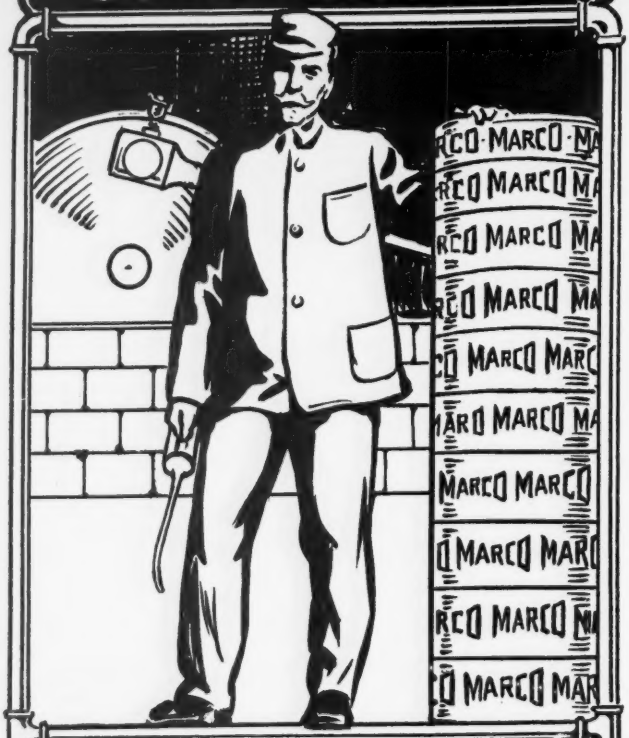
SAN FRANCISCO, 115 Davis Street
LOS ANGELES, 355 E. Second Street
HONOLULU, 42 Queen Street
HAVANA, Tacon 8.

ITS BRAINS THAT MAKE AN ENGINEER ITS BRAINS THAT MAKE GOOD PACKING



A LITTLE RUBBER AND A LITTLE FABRIC THROWN TOGETHER DON'T MAKE GOOD PACKING.

REALLY GOOD PACKING
requires, first of all, the best materials obtainable—we use nothing but the choicest that money can buy.

BRAINS
to determine the correctness of the principle, are absolutely essential—our staff consists of practical men who know their business.

OUR WORKMEN
have grown up in the Packing business and are as skilled as long practice can make them.

TRADE MARK
MARCO
REG. U.S. PAT. OFF.

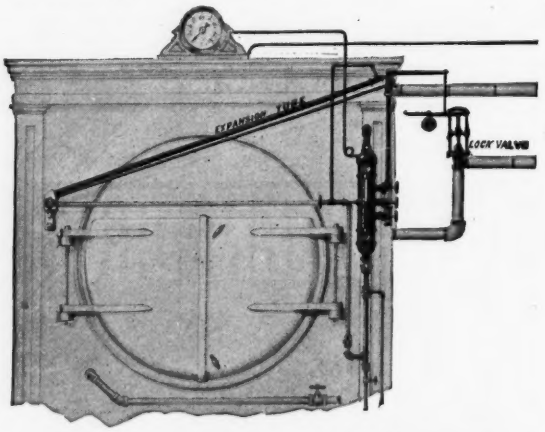
PACKINGS
result from this combination and a more honest, more reliable product was never made.

Our MARCO DIAGONAL is a Packing to be proud of. It never fails to please and a trial order always insures more.

The Tip of MARCO DIAGONAL cannot peel and it has other new and good features. Don't take our word for it; write for samples and satisfy yourself.

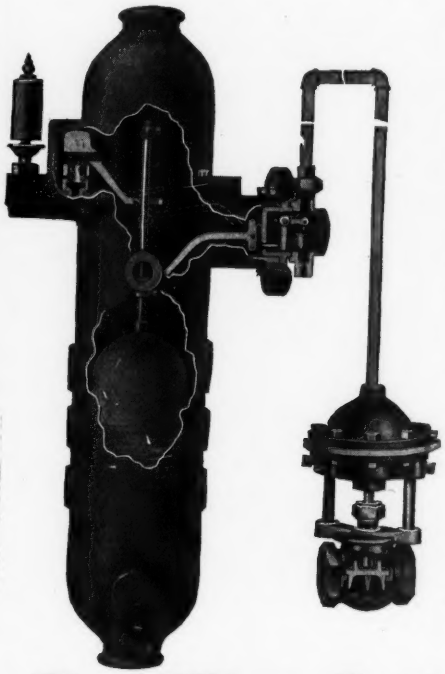
THE MECHANICAL RUBBER CO.
74 Lisbon St., Cleveland, O.

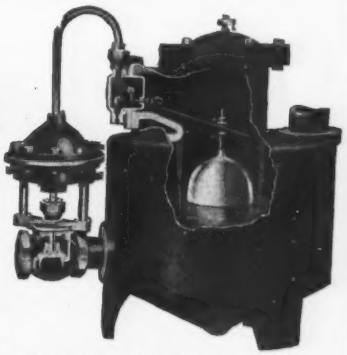
Suppose the water in your boilers would fall below the gauges, what would you do? Would you take a chance or would you pull the fire? The first would be dangerous, the other expensive; yet you may have to choose between them any day. Nearly every engineer has had to do so, some of them, many times. Usually he takes a chance and usually he gets away with it. He does it to save the expense of a shut down. But what a chance it is. Think of the lives that have paid for "low water." Or suppose your water gets too high as it frequently does in some plants; and, suppose your engine gets a slug of water; it may be a cylinder head, a piston or a cross head, or all three and the cost of a shut down. Why not prevent it? Protection is cheaper than repairs. An ounce of prevention is worth a pound of cure.



AMERICAN BOILER ECONOMY CO.
741 Mutual Life Bldg. Philadelphia, Pa.
Successor to WILFONG & WILTBANK
AGENTS FOR NEW ENGLAND STATES,
The New England Roller Grate Co., Whitney Bldg., Springfield, Mass.
REPRESENTATIVE FOR MARYLAND AND DISTRICT OF COLUMBIA
John H. Walter, 1009 American Building

WILLIAMS SAFETY FEED - WATER REGULATOR





WILLIAMS STEAM OPERATED TRAP

is in use on over four million h. p. of boilers in the best plants in the world. It pays in increased efficiency, economy, and protection against boiler explosion and repairs. It insures a uniform water level in the boilers, prevents foaming with its cutting of valves and cylinders and improves the entire system.

WILLIAMS STEAM TRAP

has a discharge like a gun shot, there is absolutely no trap duty that it will not perform. You cannot realize the enormous capacity of this Trap until you have seen it in operation.

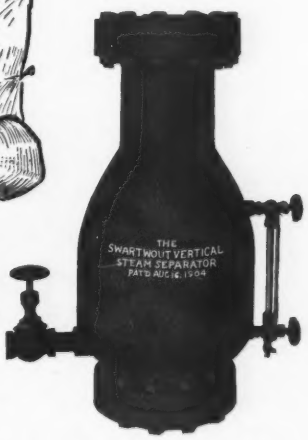
Williams Pump Governor operates on 4 ounces variation. Simple, Reliable. Guaranteed for a year.

WRITE FOR LARGE NEW CATALOG

WILLILMS PUMP GOVERNOR

The Williams Gauge Co., Pittsburg, Pa. U. S. A.

New York Office, 39 Cortland St. Philadelphia Office, 718 Girard Bldg. Boston Office, 610 Tremont Bldg.



Don't buy an Imperfect Steam Separtor at any price

Imperfect separation is Dangerous and Expensive

——BUY THE——

"Swartwout Vertical"

(THE SEPARATOR WITHOUT FAULT)

It separates thoroughly by Centrifugal Force, the simplest and surest process known. No condensation—no shaking or vibration of pipes—no danger of throttle valve bursting, wrecking of engine, or loss of life—All **SWARTWOUT SEPARATORS tested** at 400 pounds pressure and **guaranteed** for 150 pounds working pressure. Write to-day for illustrated descriptive booklet in detail. Better be safe than sorry.

THE OHIO BLOWER CO.

43-47 Michigan Avenue CLEVELAND, OHIO

Climax FORCE FEED Lubricator

WITH SIGHT-FEED—Patented

RADICALLY differs from all others and LEADS all

IT IS MOST POSITIVE because it has a slow suction and quick stroke

IT IS MOST ACCESSIBLE because it has outside valves

IT WILL LAST YEARS

IT HAS A PERFECT SIGHT FEED

CATALOGUE will tell you why it is better than any other

Climax Lubricator Co.

3 Appleton St., Boston, Mass.

Philadelphia Representative

L. BANCROFT MELLOR
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"FORCE-FEED is the only positive lubrication"

Boston Renewed Incandescent Lamps

give you satisfaction and saves you money.

Why not order now? Address direct from factory.

Boston Incandescent Lamp Co.
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The Detroit Lubricators

Are Standard the world over.

More than 850,000 of them are in use.

Look for the GENUINE ORIGINAL PACKAGE. Catalogue on Application.

Detroit Lubricator Co.
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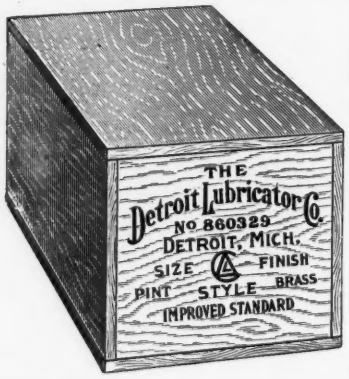
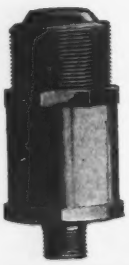


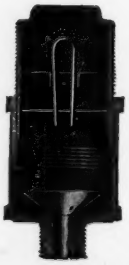
The "PHILADELPHIA" GREASE CUP

Automatic application of grease to the bearings without the use of spring compression.

Nature supplies the Feeding Force in the Form of Compressed Air.

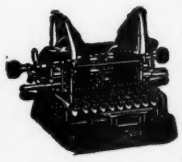


The "Philadelphia" Cup satisfies the ENGINEER because it saves him time, attention and labor; removes all worry about the condition of his journals, and enables a better showing of expense account. Every engineer should have our treatise entitled,—"The Lubrication of Machinery Bearings." It is interesting and instructive. Shall we send you a copy?



The Philadelphia Lubricator & Mfg. Co., Inc.
"THE BOURSE" (Exhibition Dep't.) PHILADELPHIA, PA.

YOU CAN EASILY OPERATE THIS TYPEWRITER YOURSELF



Don't worry your correspondent.

Don't write him anything by hand that akes him time to make out—that may leave him in doubt—that he can't easily read.

And don't fil out ega. papers or card memos—or make out accounts in your own handwriting.

It looks bad, reflects on your standing, makes people think you can't afford a stenographer, and is sometimes ambiguous.

You can write out your letters—make out an abstract—fill in an insurance policy—enter your card memos—make out your accounts, or a hotel menu—or do any kind of writing you need, on any kind, size or thickness of paper and space any way you wan on

The OLIVER Typewriter

***The* Standard Visible Writer**

You can write any of these things yourself if you do not happen to have a stenographer.

For you can easily learn with a little practice, to write just as rapidly and as perfectly, as an expert operator on the OLIVER. Because the OLIVER is the simplified typewriter. And you can see every word you write. About 80 per cent. more durable than any other typewriter, because it has about 80 per cent. less wearing points than most other typewriters.

Eighty per cent. easier to write with than these other complicated, intricate machines that require "humoring"—technical knowledge—long practice and special skill to operate.

Than machines which cannot be adjusted to any special space—with which it is impossible to write abstracts, insurance policies, or odd-size documents except you buy expensive special attachments requiring experts to operate.

You can adjust the OLIVER to any reasonable space—you can write on any reasonable size and thickness of paper, right out to the very edge, without the aid of any expensive attachment or special skill, and your work will be neat appearing, legible and clear

Forth e OLIVER is the typewriter for the doctor, the awyer, the insurance agent, the merchant, the hotel proprietor—or any man who does his own writing.

Write us now for our booklet on the simplified features of the OLIVER.

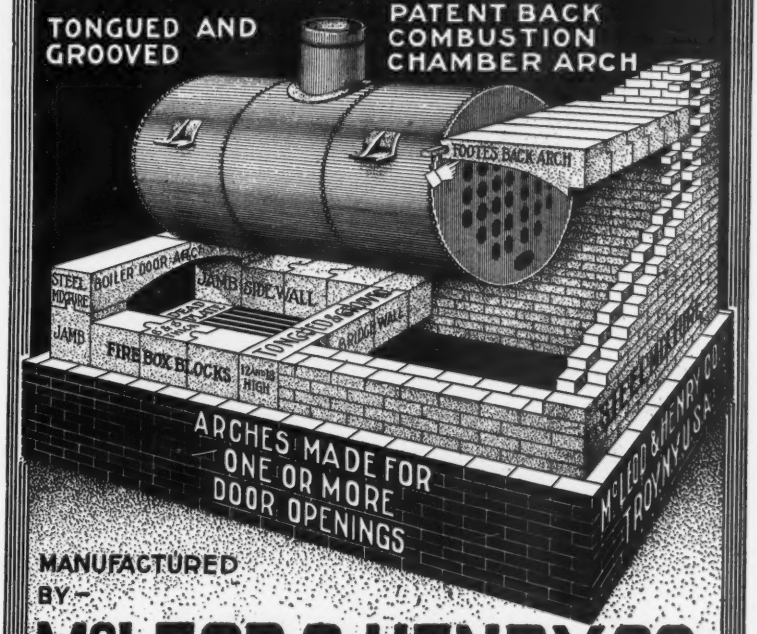
***The* OLIVER Typewriter Co.**
WALNUT AND TENTH STS.
PHILADELPHIA, PA.

"STEEL MIXTURE"

BOILER DOOR ARCHES AND FIRE BOX BLOCKS

TONGUED AND GROOVED

PATENT BACK COMBUSTION CHAMBER ARCH



ARCHES MADE FOR ONE OR MORE DOOR OPENINGS

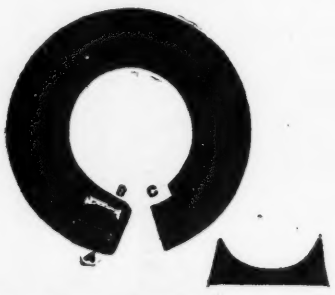
MANUFACTURED BY—

McLEOD & HENRY CO.

INQUIRIES SOLICITED. TROY, N.Y., U.S.A.

BRANCH OFFICE:—
JOHN H. FOOTE, Manager
1402 BROADWAY—ROOM 1125—KNICKERBOCKER BUILDING—NEW YORK CITY

Walsh Metal Face Packing



A—Fibrous Packing. **B**—Metal.
C—Open space to avoid butting when cover is worn off.
D—Section of metal cut out at C.

Adapted to all kinds of Steam and Water Packing. Will not cut Rods, will not wear rods to shoulder, will not harden under compression. More durable than fibrous packing. Less friction, as it is lubricant of itself. For packing engines, steam hammers, cranes, valves, expansion joints, pumps, elevators, accumulators, hot-water plunger pumps, etc. **Cotton, Linen and Square Flax Packing in Stock.**

PACKING FOR ELEVATORS a Specialty

Walsh Packing Co.

1118 and 1120 S. Seventh St., Philadelphia, Pa.

Walsh Combination Gaskets

WILL NOT BLOW OUT

Can be used from 10 to 40 times.
The Cheapest Gasket Made.

A—Soft Metal. **BB**—Rainbow Rubber. Composed of Soft Metal and Rainbow Rubber as shown in cut. Made different widths and thicknesses for man and hand hole Gaskets

EUREKA PACKINGS

Time Tells the Tale

For more than five and twenty years the hands of time have been assisting us to build up the reputation of our packing. Once we staked our all on a single soft packing, which we named EUREKA. We now style it EUREKA GUM CORE.

EUREKA GUM CORE has "made good" for over a quarter of a century. Now we stake our quarter-century reputation—our ability to make and deliver the goods—that each one of the seven kinds of EUREKA PACKINGS that we mention will stand the test of time and wear and tear just as stanchly as the first packing that bore the name EUREKA.

Ask your dealer for a sample of any or all of the seven kinds of EUREKA PACKINGS or send direct to us.

EUREKA PACKING CO.

Sales Department JAS. L. ROBERTSON, Pres.

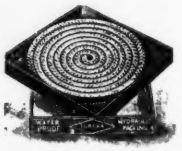
Our associates, Jas. L. Robertson & Sons, are still offering most liberal terms, cash or otherwise, for Robertson-Thompson Indicators, Willis Planimeters and Victor Reducing Wheels, and if you are in need or expect to need a Hine Extractor, a Damper Regulator, an Exhaust Head, a Waste Oil Filter, a Feed Water Heater or a Shaking and Dumping Grate.

WHY NOT LET US KNOW?

Our Prices are Bound to Suit.

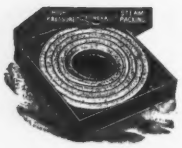
Jas. L. Robertson & Sons, Inc.

40 Warren Street New York



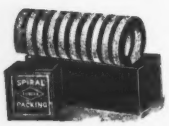
Eureka Water Proof

Eureka Gum Core



Eureka High Pressure

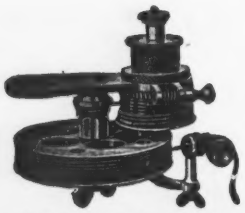
Eureka Square Flax



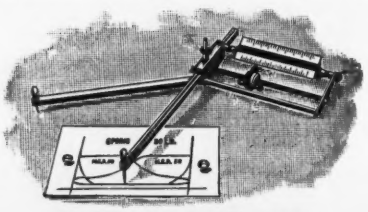
Eureka Spiral

Eureka Ring

Eureka Sheet



A Victor Reducing Wheel



The Willis Improved Planimeter

Robertson-Thompson Indicator

LORD'S

HERE ARE TWO ILLUSTRATIONS OF OUR METHODS

Samples of boiler scale were analyzed by us for the following concerns :

16345

OCTOBER 19, 1905.

SCALE.

H. H. Babcock Co., Watertown, N. Y.:

Organic and Volatile	4.5 per cent.
Calcium Sulphate	89.7 per cent.
Silica	4.5 per cent.
Iron Oxide and Alumina	1.3 per cent.
Calcium Carbonate	a trace.
Magnesia	a trace.

PHYSICAL CHARACTERISTICS.

Thickness, $^{3}/_{64}$ in., 1.2 m.m.
Hardness, very hard.
Structure, crystalline.

16823

NOVEMBER 20, 1905.

SCALE.

Tompkins Electric Co., Rugby, N. D.:

Organic and Volatile	10.4 per cent.
Calcium Carbonate	24.0 per cent.
Calcium Sulphate	36.8 per cent.
Magnesia	21.3 per cent.
Silica	7.5 per cent.

PHYSICAL CHARACTERISTICS.

Thickness, $^{5}/_{64}$ in., 2.0 m.m.
Hardness, very hard.
Structure, crystalline and amorphous.

Look these over. You will see how different they are. You can see that the chemicals that would work in one case would not do for the other. We wrote each party that we could make a special prescription of Lord's water purifying chemical for that particular case. Each one sent us an order. If you want to know what results were obtained; read these letters:

WATERTOWN, N. Y., July 17, 1906.

Geo. W. Lord Co., Philadelphia, Pa.:

GENTLEMEN: We would state that we commenced using the compound you sent us on or about April 15th last, and on the last examination of the boilers (July 8th) found them almost entirely free from scale, and notice that the boilers steam better than they have for some time.

Yours truly,
H. H. BABCOCK CO.

RUGBY, N. D., March 20, 1906.

Geo. W. Lord Co., Philadelphia, Pa.:

GENTLEMEN: In answer to yours of March 8th, will say that the compound is O. K. The scale is nearly all off, and we are saving 25 per cent. in fuel. Before we used the compound we had to run both boilers; now we can run with one.

Yours truly,
G. W. BRUNDAGE,
Engineer Tompkins Elec. Co.

This shows you how we go about it.

We ask you to send us a sample of scale with coupon.

We will analyze it free of charge and send you Certificate of Analysis, and our new book. You do not have to buy just because you send us this piece of scale; but, if you do, we will send you a special prescription for your boiler made up from the analysis of the scale.

GEO. W. LORD COMPANY

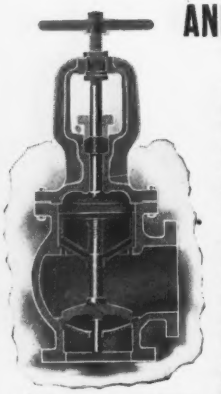
2238-50 N. 9th St., Philadelphia, Pa.

The Geo. W. Lord Co.
2238-50 N. 9th Street,
Philadelphia, Pa.

Gentlemen: I am sending you a sample of scale from our boiler. You are to analyze it, and send me, free of charge, a certificate of analysis and the book.

*Number of boilers in use*_____
*Capacity of each boiler*_____
*Frequency of cleaning boilers*_____
*Frequency of opening the blow-off during working hours*_____ *River or other source of water supply* _____
Boilers are used about _____ *hours out of 24*
*Coal burned per day*_____
Water evaporated per day _____
*Name*_____
*Street and Number*_____
*City*_____ *State*_____
Firm's Name _____
Date_____

PRAC. ENG.



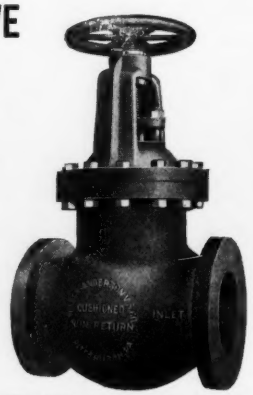
XX EXTRA HEAVY

ANDERSON PATENT CUSHIONED NON-RETURN VALVE

PROTECT YOUR BOILERS WITH AN ABSOLUTE SAFETY STOP

These Valves, when placed between the boiler and header, Equalize the pressure between the Different Units of a battery of boilers, as they remain Closed as long as the boiler pressure is Lower than that of the Header. When the boiler pressure Equals that of the head pressure, they Open and remain in that position without Chattering or Hammering. They automatically cut off a boiler in case of accident to boiler, such as bursting of a tube, and also act as a Safety Stop to prevent steam being turned into a cold boiler, which also means a safeguard for men working inside.

Then why endanger your power plant by using the regular Angle, Globe or Gate Valves at the boilers, when you can get the Anderson Cushioned Non-Return Valve, which is an Automatic Stop Valve, also a Hand Stop Valve, all in one. The sectional cut shows plainly the perfect Dash-pot arrangement for cushioning these valves, which is so Essential in order to avoid the Chattering and Hammering Existing in this class of Valves. The sectional cut also shows the inside Dash-pot attached to the valve spindle, whilst the outside Dash-pot is loose on the spindle, also FREE to move in the body.—in a word, a Corliss Dash-pot, occupying the full area of the body, thus absolutely insuring the perfect cushioning feature and the perfect alignment of the Valve. **"The Valves With an Absolute Guarantee," Where is Their Equal?**

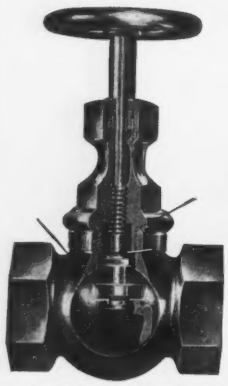


HEAVIEST VALVE MADE

The Golden "NON-CORROSIVE" "NON-SETTING" Steam Gauge

DOUBLE SEAMLESS BRASS AND STEEL DRAWN TUBES

Did you ever see a Steam Gauge with Double Seamless Brass and Steel Drawn Tubes? Here it is the most Accurate and Durable TUBES that have ever been designed for Gauge Service.—A Seamless BRASS TUBE within a Seamless STEEL TUBE, drawn and treated by a Secret Process, making them Non-Corrodible, non-setting, hence they are not effected by Vibration, Shock, or Crystilization that is so ruinous to Gauges. If you want the best and most reliable gauge made; no other gauge will fill your bill. Every tube is tested to 1000 pounds.



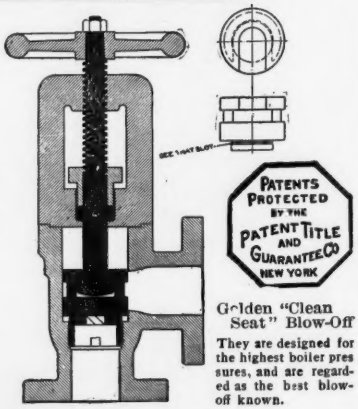
Golden "Clean Seat" Valve

The Golden "Clean Seat" Valve

"BUILT FOR SERVICE"

IT CLEANS ITS OWN "SEAT AND DISC"

The bottom of disc is hollow, with solid cast eccentric lugs on the side. Slot or groove is cut between the lugs and entire outside diameter, so when the slot or groove comes flush with seat, steam, water, or air iets direct across the seat and disc. The heaviest, most economical and durable valve made. Also made for Hydraulic and compressed air service.



Golden "Clean Seat" Blow-Off

They are designed for the highest boiler pressures, and are regarded as the best blow-off known.

THE GOLDEN "CLEAN SEAT" BLOW OFF

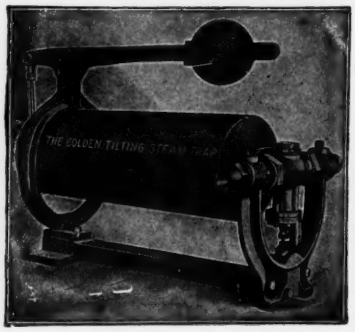
is as simple and self-cleaning as the Globe and Angle valve. Body is iron fitted with renewable bronze seat and solid bronze valve or disc, with babbit or other flexible metal insertion that can be quickly refilled if found necessary.

ANDERSON PATENT Float Valve

"Simply has no Equal!"

The Valve with an Absolute Guarentee

Cushioned in opening and closing. Float swivels to any angle desired. For high and low pressure. Absolutely controls the water level in tanks or reservoirs. Instantly adjusted to operate quick or slow, as desired. "No waste of water!" The upper portion of body being lined with bronze, also the valve or piston being solid bronze, makes the valve indestructible. Firms that are using them say, "their equal is not made."



The Golden Patent High and Low Pressure Tilting Steam Trap

For all pressures, up to and including 275 pounds. A revolution in steam trap construction. One valve for all pressures and of enormous capacity. No FLOATS—NO VALVES—NO BUCKETS inside of traps; all working parts outside—compensating roller bearing in lever; no shock or jar, hence no wrenches required; simply tighten up trunnion nuts by hand is all that is necessary. We guarantee these Traps.

The heaviest line of AUTOMATIC VALVES and TRAPS ever presented to the trade.

GOLDEN-ANDERSON VALVE SPECIALTY CO.

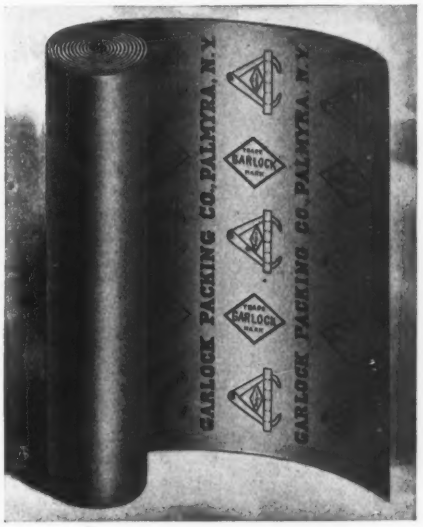
107 SIXTH STREET, PITTSBURG, PA.

GARLOCK OIL PROOF SHEET PACKING

THIS is a fine, high-grade Sheet Packing for high pressure steam. For pipe flanges that are affected by vibration it is the best packing made. It is unequalled for Gas, Naptha, Benzine, Tar or Syrup and positively **Oil** proof.

It makes either rough or smooth joints equally well, and perfectly tight when first applied. We make many other kinds of Sheet Packing for various uses, but we do not make any thing as good, nor does any one else make any packing that is as good as this for the specific uses mentioned above.

WRITE FOR OUR GENERAL CATALOG



STYLE No. 153

The GARLOCK PACKING CO.

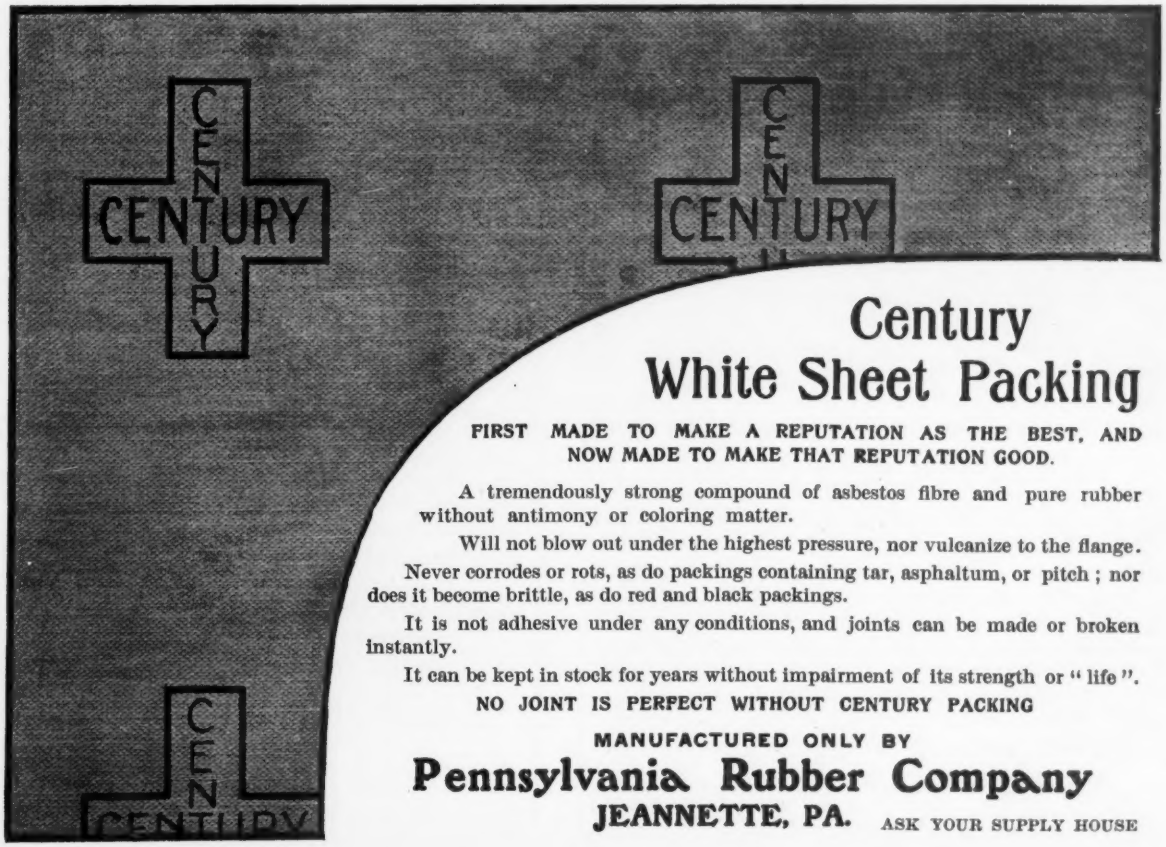
Main Office:— Palmyra, N. Y., U. S. A.

FACTORIES

Palmyra, N. Y. Denver, Colo. San Francisco, Cal.
Atlanta, Ga. Hamburg, Germany New Orleans

STORES

Philadelphia St. Louis New York Atlanta, Ga.
Cleveland Denver Chicago Palmyra, N.Y. Pittsburg
San Francisco Boston Hamburg, Germany New Orleans



Century White Sheet Packing

FIRST MADE TO MAKE A REPUTATION AS THE BEST, AND NOW MADE TO MAKE THAT REPUTATION GOOD.

A tremendously strong compound of asbestos fibre and pure rubber without antimony or coloring matter.

Will not blow out under the highest pressure, nor vulcanize to the flange.

Never corrodes or rots, as do packings containing tar, asphaltum, or pitch; nor does it become brittle, as do red and black packings.

It is not adhesive under any conditions, and joints can be made or broken instantly.

It can be kept in stock for years without impairment of its strength or "life".

NO JOINT IS PERFECT WITHOUT CENTURY PACKING

MANUFACTURED ONLY BY

Pennsylvania Rubber Company

JEANNETTE, PA. ASK YOUR SUPPLY HOUSE

There Are Reasons For It.

The Patterson-Berryman Feed Water Heater and Purifier

AND

The Patterson Belt Pump

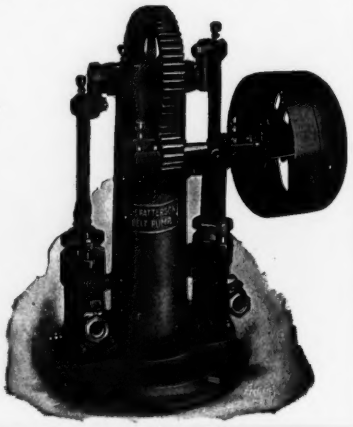
are sold on trial with the distinct understanding that they may be returned to us at our expense should either prove unsatisfactory. *Because*

They are manufactured of the best material and workmanship.

Their efficiency and durability is the highest.

They are simple in construction reducing repairs to the minimum.

If you are interested we would like to explain whys and wherefores.



Frank L. Patterson & Co.
24 Cortlandt Street,
NEW YORK

Berryman

Feed Water Heaters and Purifiers

WATER TUBE AND STEAM TUBE

Cast Iron or Steel Shells. "U" Shaped Seamless Drawn Brass Tubes.

We Build Heaters for every Purpose and Condition

THE KELLEY PATENT
Improved Berryman Water Tube, Feed Water Heater and Purifier

BENJ. F. KELLEY & SON, Makers
120 Liberty Street, NEW YORK

JOHNSON'S HANDY MANUAL

contains hundreds of valuable hints and short cuts to lighten the labor of the Engineer in connection with steam piping and fitting. Tells how to ascertain the length of pipe required in 45 deg. angles; how to take measurements of of pipes and fittings; how to determine exposure and proportion radiation; the proper method of taking off connections in steam and hot water piping, etc. **Price $1.00**

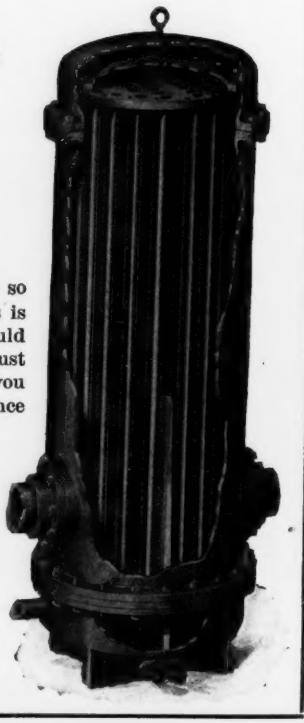
MONEY BACK IF UNSATISFACTORY

DOMESTIC ENGINEERING,
58-64 N. Jefferson Street, **CHICAGO**

The straight tube heater has many advantages over the bent tube and not the least of these is the ease with which the tubes can be removed and replaced.

The Jacobs Patent Feedwater Heater and Purifier

has been in use so long and is so well know that its usefulness is not questioned, but we would like to send you our catalog just the same. We can save you money and want the chance to do so.



Chas. Jacobs & Co.
49 Oliver St.
BOSTON, MASS.

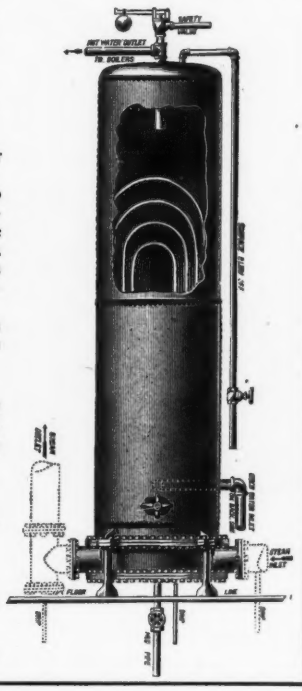
AGENTS
Emil A. Briner
639 Bourse Building
Philadelphia, Pa.

R. B. Murray
Farmers Bank Building
Room 511, Pittsburg, Pa.

The

BERRYMAN

Feed Water Heater and Purifier



Is acknowledged to be the leader of all feed-water heaters.

The Berryman enables you to heat your feed water with the exhaust steam to the highest degree obtainable, thereby creating a saving in fuel and boiler repairs sufficient to more than pay for itself in one years time,

Provided with ∩-shaped drawn brass tubes, expanded into the same tube plate, and

THEY NEVER LEAK.

The Berryman is the heater of Capacity, Simplicity, Durability and Reliability under all working conditions.

I. B. DAVIS & SON,
MAKERS
Hartford, Conn.

WRITE FOR CATALOGUE TO
THOS. McADOO,
125 N. Fourth Street, Phila., Pa.

"I'm more than satisfied with my

COCHRANE"

There's a heap of satisfaction in having something good—in having a Cochrane Heater, or a Cochrane Separator, for example. Ever own a horse that was a bit better than the other fellow's—a little faster—one that could go a little further—one that always seemed to be in condition, and a good looker besides? In other words, you are getting results out of that horse—you are glad you bought him and you are glad that you did not buy the cheaper nag that was offered you at the same time.

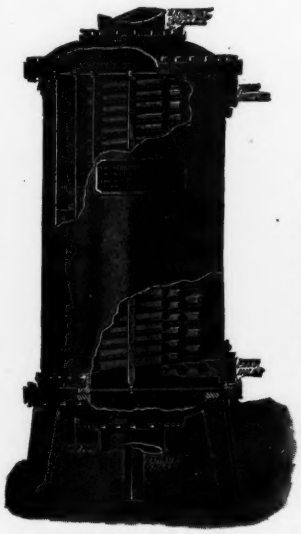
Now besides the horse itself, somebody brought him up in the right way; you are getting the benefit of the other fellow's "know how."

Same with Heaters—Feed Water Heaters. The people who know "Cochranes" are glad they have got them and the next time they buy, they are going to buy another "Cochrane." They liked the way we treated them and the care that we take to see that everything is all right. Then they have the satisfaction of knowing that they have got the best. Meanwhile, the Cochrane Heaters are making a reputation for us.

Some day we hope you will be sufficiently interested to write us in order to find out why people, representing 4,000,000 hp. of boilers, have bought "Cochranes."

Harrison Safety Boiler Works — COCHRANE HEATERS — **3144 N. 17th St. Philadelphia**

The American Standard Copper Coil Feed Water Heater



Simplicity!
Strength!
Economy!
A Money Saver!

It gives so little trouble that one of our customers, who has used one for three years, had forgotten that he had it when we asked him the other day how it was doing. He called in the engineer, who said it hadn't been touched since it was put in and was still heating the water to 210 degrees.

THAT.S THE KIND OF A HEATER YOU WANT.

Write for Catalogue No. 100 P

The Whitlock Coil Pipe Co.

HARTFORD CONNECTICUT

A Dollar An Hour
Instead of
A Dollar A Day

Don't be satisfied with a small salary all your life—do as thousands of others have done; let the **International Correspondence Schools** show you how your pay can be increased. It matters not where you are, in the boiler pit or in the engine room, in the mine or in the mill, in the office, store, or shop, the **I. C. S.** can and will increase your earning capacity. *A Dollar an Hour* is not out of your reach, if you will only let us help you. It will cost you nothing to ask us—*How?* Clip and mark the coupon, mail it at once, and it will bring to your aid all the resources of that great institution—the **I. C. S.**, a six-million dollar establishment founded and maintained for the benefit of poorly paid men.

16 Mechanical Engineer	1 Bookkeeper
13 Mechanical Draftsman	2 Stenographer
30 Foreman Machinist	3 Ad Writer
12 Electrical Engineer	7 Illustrator
11 Electrician	9 Chemist
63 Foreman Steam Fitter	8 Civil Service Exams.
60 Plumbing & Heat. Con.	
22 Architect	
20 Contractor & Builder	
23 Structural Engineer	
54 Structural Draftsman	
39 Marine Engineer	
36 Gas Engineer	
25 Mining Engineer	
19 Civil Engineer	

International Correspondence Schools Box 835 **Scranton, Pa.**

Please explain, without further obligation on my part, how I can qualify for a larger salary and advancement to the position numbered_____

Name _____

St. & No. _____

City_____ State_____

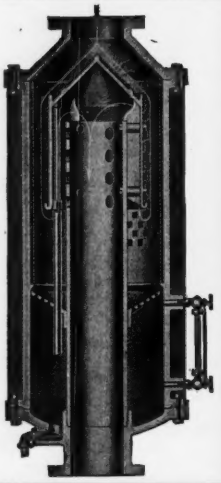
All The Time

Most separators take some water out of steam, and appear at times to be doing well, but very few remove all except one-half of one per cent **all the time**; for instance, when water is coming in quantities, they simply can't hold it, too small; or when steam is passing rapidly they have not sufficient surface to catch it, and these are just the times a separator is most needed. Send for catalog and investigate these points in

Direct Separator Co.

220 Marcellus Street,
SYRACUSE, N. Y.

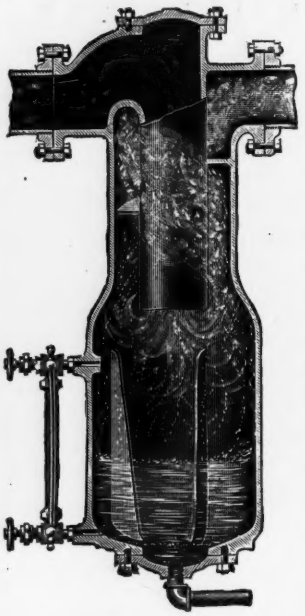
Sweet's



Separators

THE STRATTON

Steam Separator



Will deliver **Dry Steam** to your engine under any and all conditions, no matter how long your steam pipe or how much your boilers may prime.

Separation takes place by the action of centrifugal force imparted to the steam. The large capacity not only provides for a sudden influx of water but forms a reservoir of steam which equalizes the pressure between boiler and engine, thereby increases the power and stops the vibration of steam pipes; a separator of small capacity is worse than useless, it is harmful.

SEND FOR CATALOGUE

***The* Goubert Mfg. Co.**

85 Liberty Street, NEW YORK
WORKS BAYONNE, N. J.

The Baum Separator

Horizontal Style for live Steam or Oil Service.

For Live and Exhaust Steam
RESULTS GUARANTEED

Repeat orders are the best evidence of satisfactory results on the part of a satisfied customer.

"We are using the second Baum Separator and are very much pleased with the results we are getting from it," writes one who has been using Baum Separators for several years.

Write for further information before placing order. A new catalog on request.

Vacuum Style Oil Extractor.

The Baum Separator and Machine Co., MANHEIM, PA.

A Permanent Income

and steadily advancing values in the shares of this corporation is the result of the methods employed in conducting the business.

Shares selling now $1.25 each (par value $1.00).

Send for Booklet. You will be interested.

INDUSTRIAL ENGINEERING CO.
848 & 849 Drexel Bldg. Philadelphia, Pa.

THERE ARE MORE

Compound Separators

used in boilers than all others.

They insure dry steam, and protect your engine from water.

Compound Separator

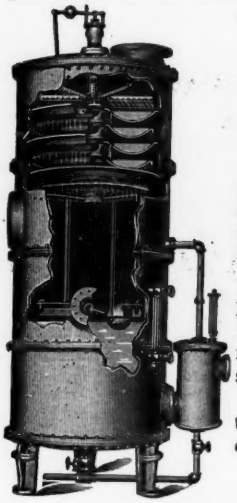
Boiler Fronts, Grate Bars, Furnace Castings, Compound Separators, and General Boiler Castings

The Kutztown Foundry and Machine Co.

WORKS:
KUTZTOWN, PENNA.
Philadelphia Office: Fidelity Building, Broad above Arch Street.

Do You

know that in the proper handling of your feed-water, before it enters the boiler lies your greatest opportunity for economy, because you can get so much for nothing by using the heat that would otherwise be wasted with the exhaust and because it is so much easier and better to remove the oil and other impurities from the water, than to remove them from the boiler in the shape of scale



The Pittsburgh Feed-Water Heater and Purifier

gives the highest possible efficiency because the feed-water is brought into direct contact with the exhaust steam. Thousands of h. p. of these heaters have been used for years in the immense steel mills of Pittsburgh where the water is notoriously bad and are giving splendid satisfaction.

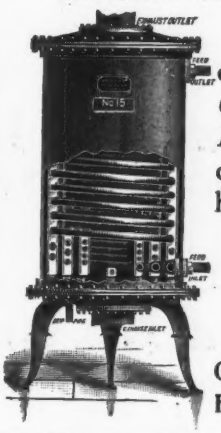
No harder test could be given them for harder conditions do not exist anywhere.

CATALOG FREE

James Bonar & Co., Inc.
716 Frick Building Pittsburgh, Pa.

The National Feed-Water Heater

2,500,000 Horse Power in Daily Use



The principal characteristics of these heaters are *Simplicity, Cheapness, Reliability and Effectiveness,* and full amount of heating surface in every heater.

Supplies Water to the Boiler at 212° F.

We manufacture the **Original and Only Genuine First-Class Coil Feed-Water Heaters.**

We Also Manufacture All Kinds of Coils in Iron, Brass and Copper Pipe

Catalogue and Prices on Application.
Manufactured and Sold Only by

THE NATIONAL PIPE-BENDING CO.
157 Lloyd St. NEW HAVEN CONN.

THE GEMMEL PATENT BOILER

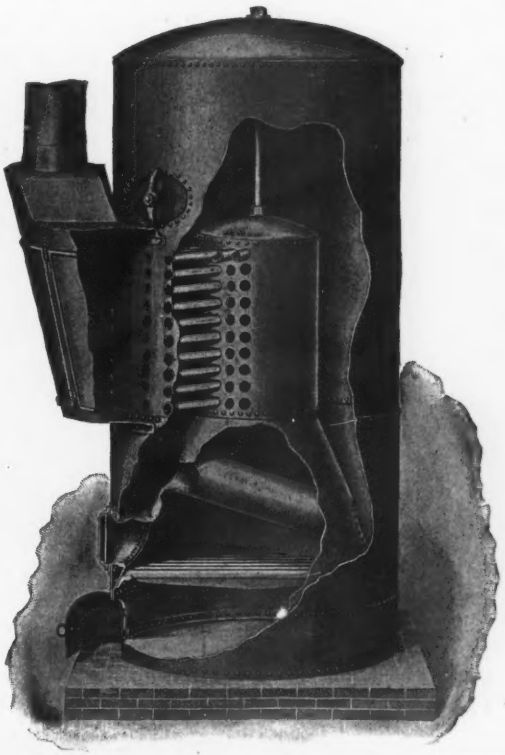
JAMES GEMMEL
Phones:—Bell, Market, 11-73 D Keystone, Main, 46-91 D

This Vertical Boiler possesses all the advantages of a Horizontal Boiler and none of its expensive disadvantages.

It requires only small floor space. It requires no expensive setting. It affords a natural path for the flue gases, and is a rapid steamer.

Its improved construction guarantees rapid circulation, and the highest degree of efficiency.

WRITE FOR ILLUSTRATED CIRCULAR AND PRICES



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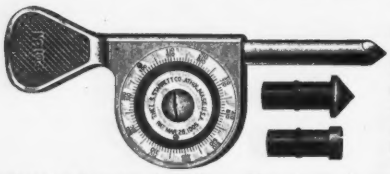

This Indicator may be run at highest speed required, without heating. The working parts are encased. Dial has two rows of figures, reading either right or left as shaft may run. Steel pointed spindle with rubber tips for both pointed and centered shafts. The O mark may be instantly set at the starting point.

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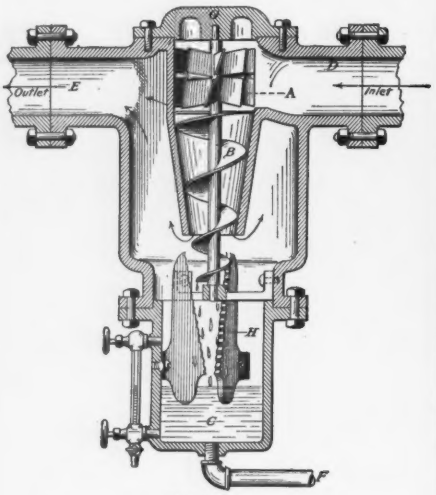

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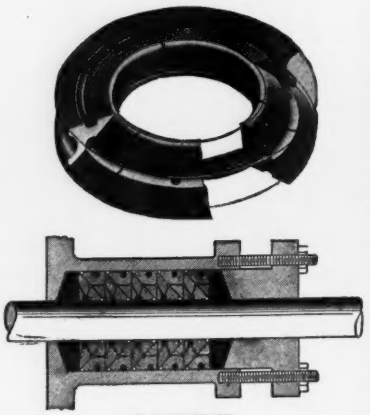

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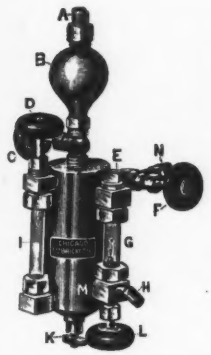

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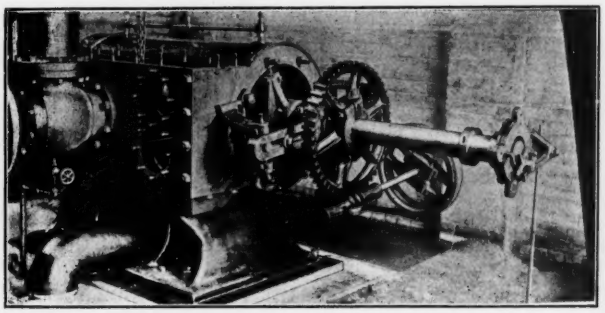

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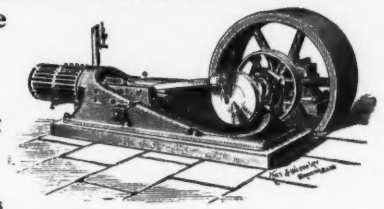

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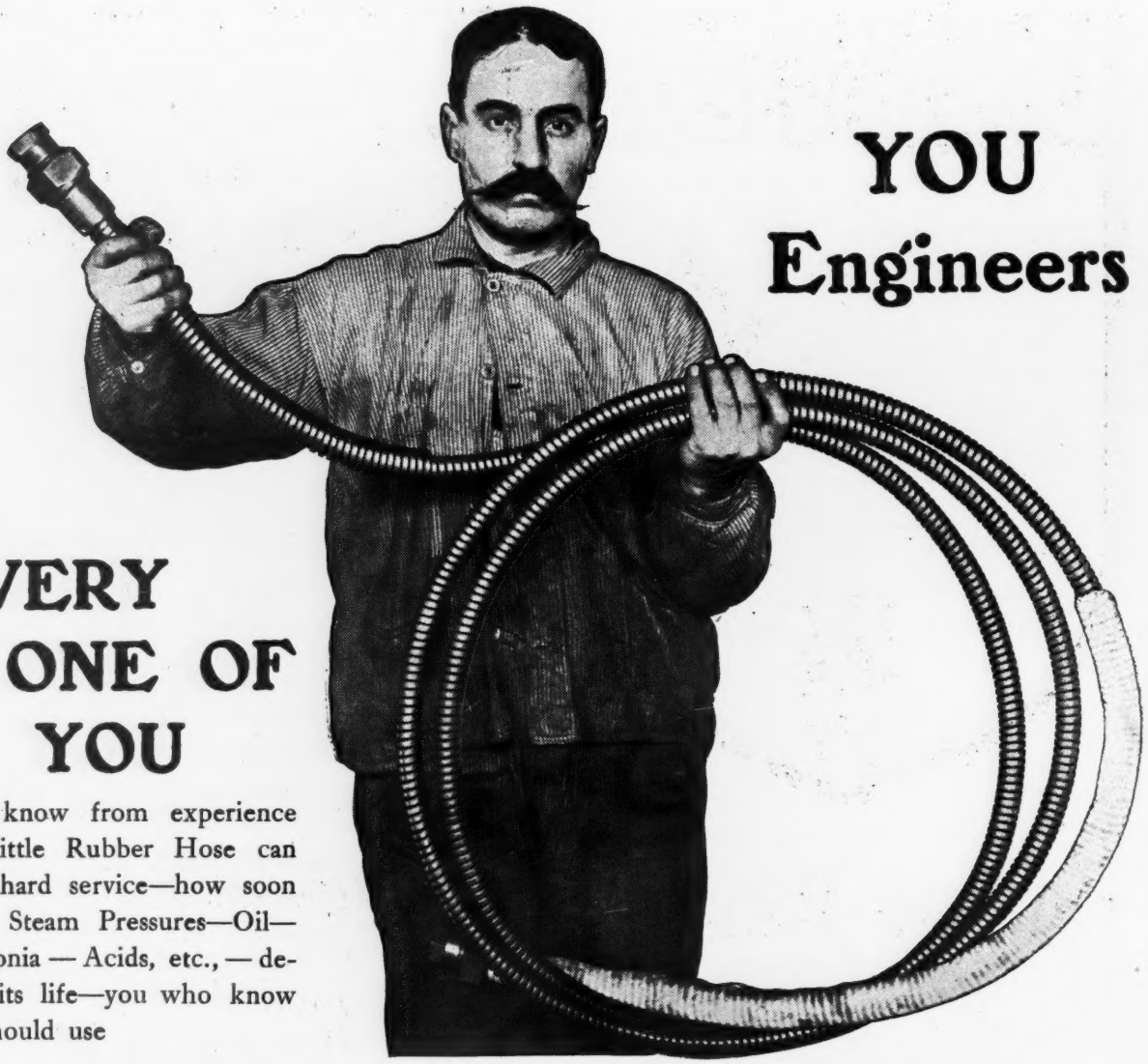

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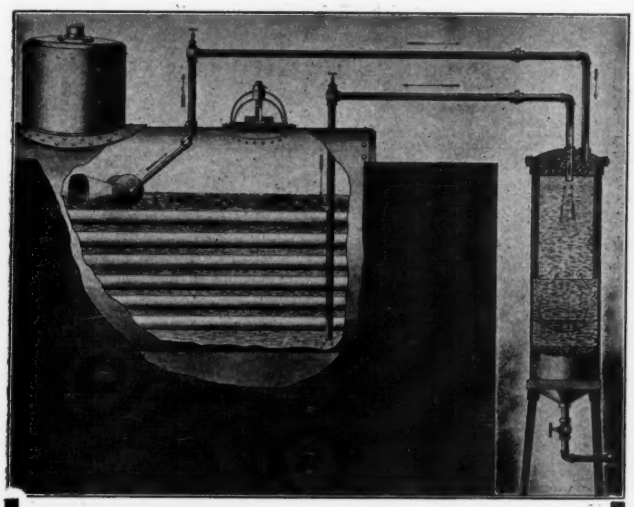

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The same water that you use in your boilers; put it on the stove and boil it violently for thirty minutes; see impurities that come to the top and it will give you a faint idea of what a thousand times that much of the same water, boiling all day long, will do to the inside of your boilers, but only a faint idea, for by far the worst of the scale forming matter which comes to the top while the water is boiling is invisible to the naked eye and owing to its greater specific gravity, settles immediately to the bottom and sides or upon the tubes where it adheres and grows harder with time. All the impurities in the water must come to the surface at some time while the water is boiling and the

Buckeye Boiler Skimmer

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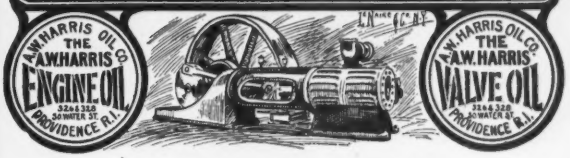

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The purpose of lubrication is to overcome the resistance of friction, to secure the greatest amount of energy from every pound of fuel burned and to reduce wear of moving parts to a minimum.

Your engine may apparently be running regularly and smoothly but this does not say economically the inroads you make in your coal pile, the amount of oil used deserves investigation, for we state emphatically that unless the oil applied is specially adapted to the purpose it is put, there will be waste at both ends.

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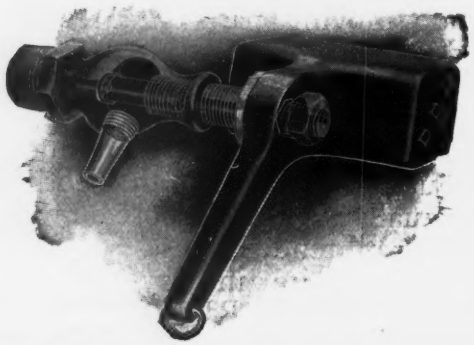

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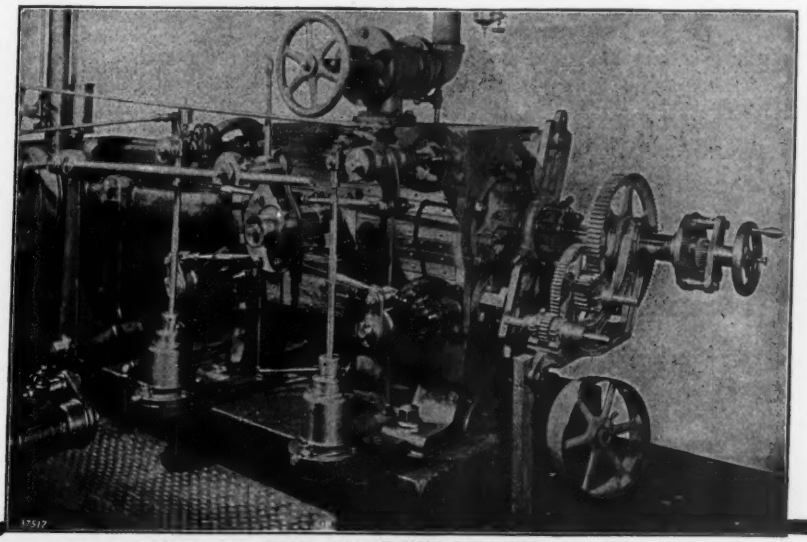

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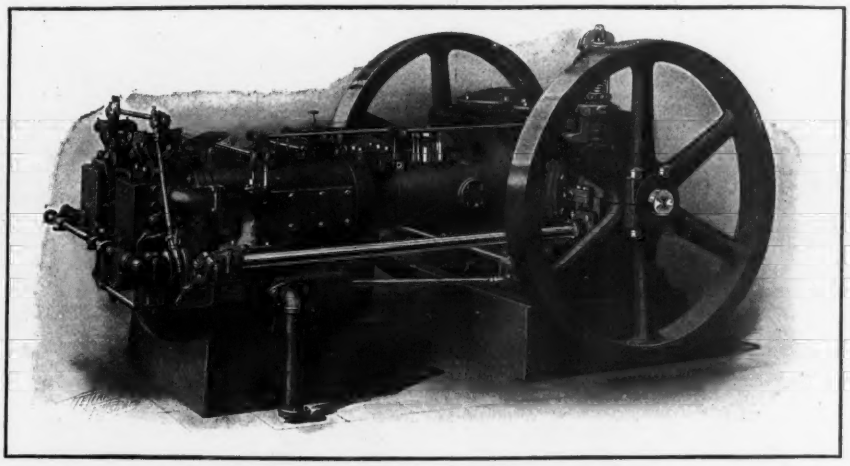

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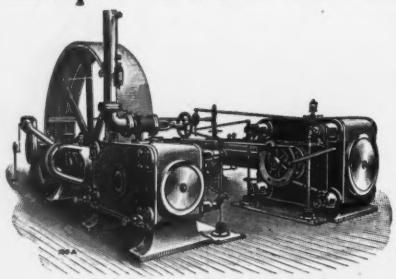

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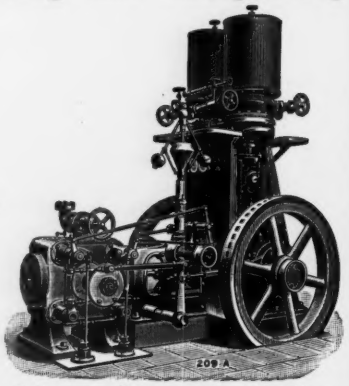

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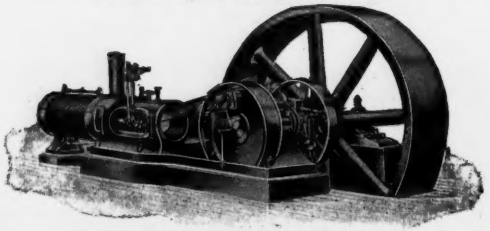

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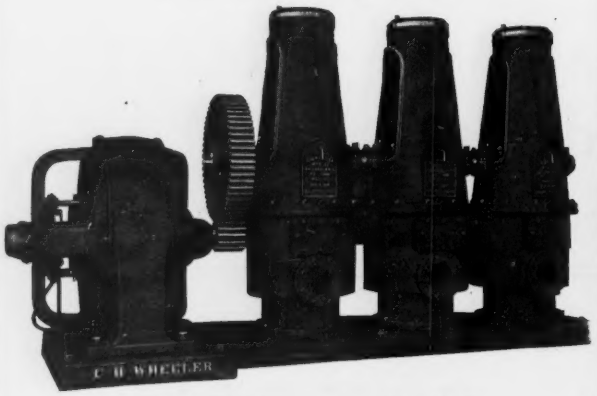

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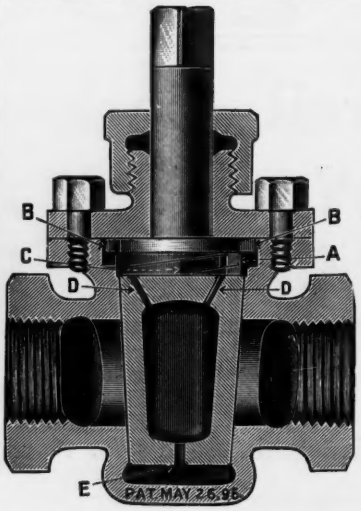

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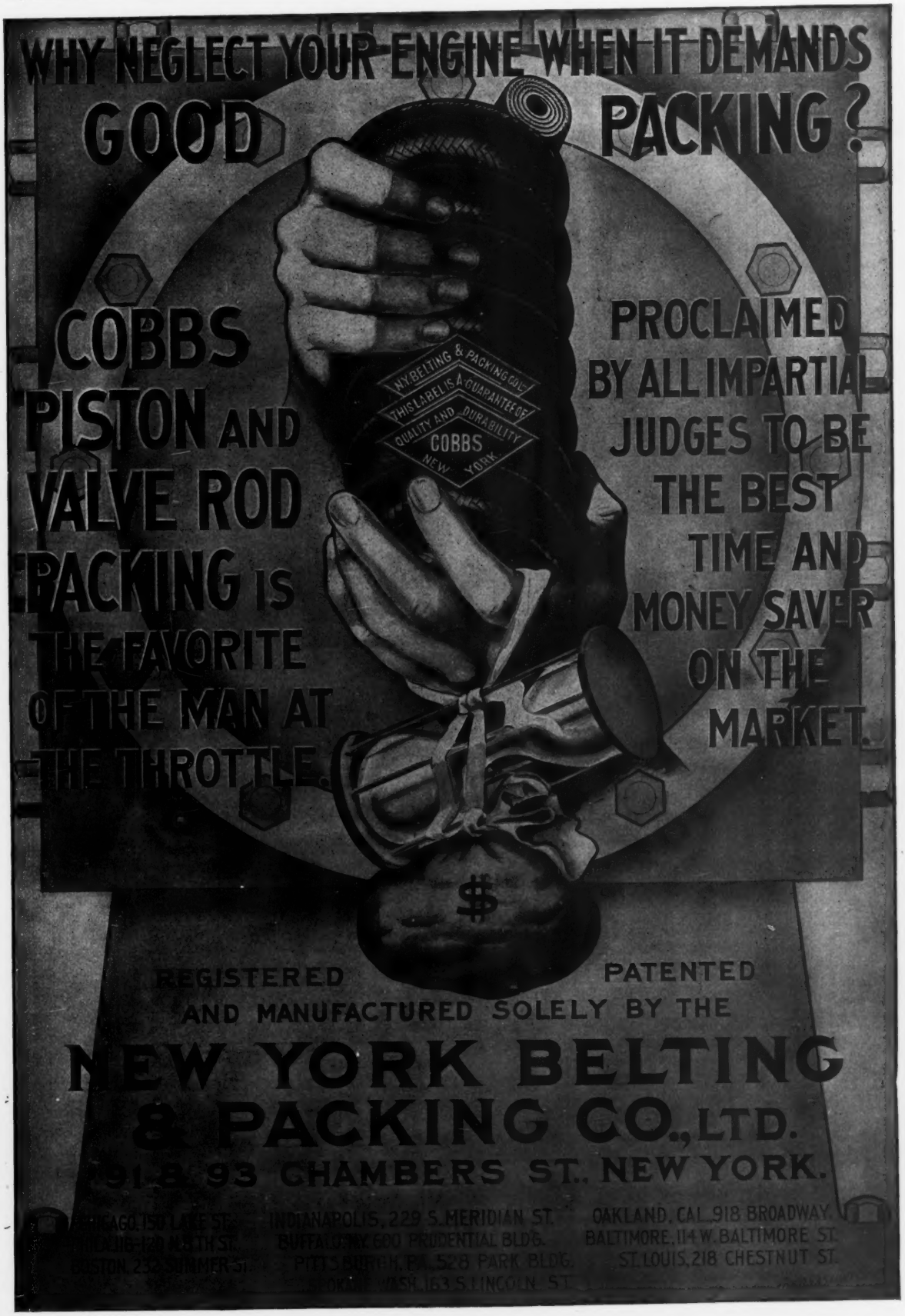
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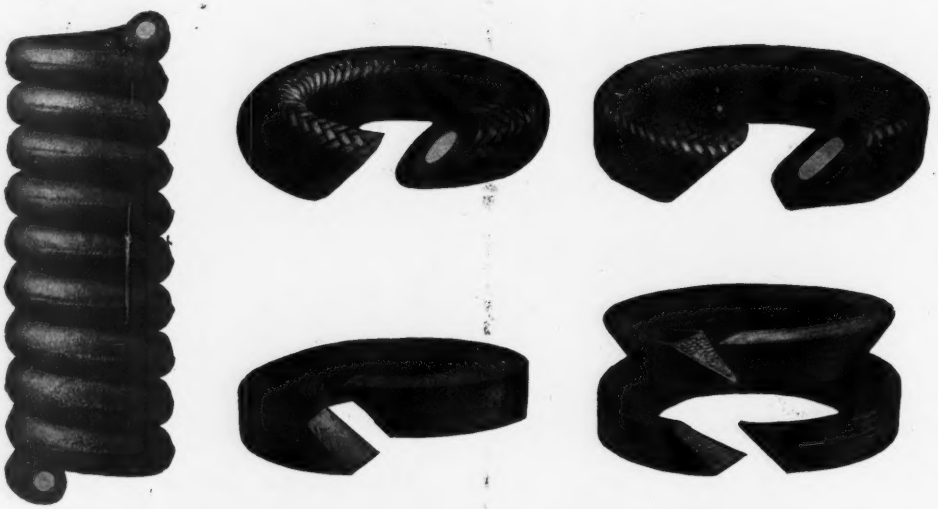

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N. E. Cor. Second and Washington Sts.
New Orleans, La.—cor. Common & Tchoupitoulas St.
Omaha, Neb.—1218 Farnam St.
Richmond, Va.—1323 E. Main St.
Philadelphia, Pa.—220 S. 5th St.

Dallas, Texas—177 Elm St.
Memphis, Tenn.—228 Front St.
St. Louis, Mo.—1212 Locust St.
Denver, Col.—1621-1639 17th St.
San Francisco, Cal.—17-23 Beale St., & 12 24 Main St.
Seattle, Wash.—Railroad Way and Occidental Ave.
Kansas City, Mo.—1221-1223 Union Ave.

Waco, Texas—709-711 Austin Ave.
Pittsburg, Pa.—634 Smithfield St.
Atlanta, Ga.—7-9 S. Broad St.
Columbus, Ohio—Cor. Long & Third Sts.
Cleveland, Ohio—61 Frankfort St.
Buffalo, N. Y.—43-45 Pearl St.
Boston, Mass.—110 Federal St.
Syracuse, N. Y.—212-214 S. Clinton St.
Rochester, N. Y.—55 E. Main St.